ASSESSING THE DEMAND FOR PHYTOSTEROL-ENRICHED PRODUCTS

A Dissertation

by

YAN YUAN

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

December 2006

Major Subject: Agricultural Economics

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Approved by

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ABSTRACT

Assessing the Demand of Phytosterol-Enriched Products. (December 2006)

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Phytosterol is a healthful ingredient that helps reduce blood cholesterol levels. It has been over ten years since the first phytosterol-enriched product, Benecol margarine, was launched in Finland in 1995; however, understanding of this product is still limited. In addition, it has been shown in the literature that health-related concerns have an influence on consumers' decisions to consume harmful or beneficial ingredients.

This study estimates the demand for three phytosterol-enriched products in the categories of margarine, orange juice and yogurt. The objectives of this study are (1) to estimate price and expenditure elasticities for phytosterol-enriched brands and comparative non-phytosterol brands, (2) to identify cannibalization effects with a proposed methodology, and, (3) to estimate the welfare effects associated with the introduction of a product.

Subsuming LA/AIDS, Rotterdam, CBS and NBR demand systems, the Barten synthetic demand system is applied to margarine weekly scanner data. Phytosterol-enriched margarine brands (Benecol and Take Control) commanded significantly higher prices relative to other margarine brands. Strong substitutability

among the phytosterol brands was evident as suggested by the statistically significant and relatively large compensated cross-price elasticities.

Cannibalization is defined as the competition between products offered by the same firm. Cannibalization studies are important to multi-product firms 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. However, there are no standard measures to identify its effects. We use the Barten synthetic demand system along with two conventional measures to illustrate that the use of cross-price elasticities derived from a flexible demand system is a viable alternative to identify cannibalization effects.

The third objective analyzes the consumer welfare effects associated with a new functional food product introduction. Using the Barten synthetic model and pre- and post-introduction scanner data, we estimate direct price and variety effects associated with the introduction of a new functional food product (i.e., phytosterol-enriched product). With post-introduction data and an assumed demand structure, we also estimate indirect price effects. Our results suggest notable welfare effects consisting of a relatively small price effect and a large variety effect.

To my dearest mother, father and little sister

ACKNOWLEDGEMENTS

I would like to thank my committee co-chairs, Dr. Nayga and Dr. Capps for their guidance and support throughout the course of this research. Dr. Nayga is always there to answer questions and to give advice. He showed me how to approach, analyze and finally solve research problems. Special thanks go to my co-advisor, Dr. Capps, who is most responsible for helping me complete the writing of this dissertation as well as the challenging research that lies behind it.

I would like to extend my gratitude to Vicki Heard for rescuing me from various red tape crises. I also want to thank Amy Moore for her support during my study.

Besides my advisors, I would like to thank the rest of my committee, Dr. Ximing Wu, who went through Chapter V in detail and gave valuable suggestions, and Dr. Li Gan, for his insightful comments.

I would also like to thank my friends and colleagues for their encouragement, patience and help.

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CHAPTER I

GENERAL INTRODUCTION: AN OVERVIEW OF FUNCTIONAL FOODS

"Functional Foods" are foods or dietary components that may provide a health benefit beyond basic nutrition (International Food Information Council, 2000). Examples include everything from fruits and vegetables to fortified or enhanced foods. Biologically active components in functional foods impart health benefits or desirable physiological effects (IFIC, 2004).

Functional foods are widely believed to offer consumers an increased ability to reduce the risk of certain diseases or health problems (Schmidt, 2000). Consequently, functional foods have become increasingly popular in recent years. According to a recent survey by International Food Information Council (IFIC), 88 percent of consumers agree that certain foods have health benefits that go beyond basic nutrition and may reduce the risk of disease or other health concerns. These beliefs stem primarily from hearing or reading information about a food's health benefit and secondarily from personal experience (IFIC, 2005). Compared to 2002, US consumers who are aware of a link between a specific food and health benefit are more likely to actually be consuming the food with a health benefit in mind (IFIC, 2005). In the case of phytosterol, 30 percent of the survey subjects are aware that phytosterol helps reduce cholesterol levels and 47 percent are actually consuming a certain kind of

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phytosterol-enriched product.

The factors fueling U.S. interest in functional foods include rapid advances in science and technology, increasing healthcare costs, changes in food laws affecting label and product claims, an aging population, and rising interest in attaining wellness through diet (IFIC, 2005). The number of Americans who are eating foods for their functional health benefits has increased from 72 percent in 1998 to 78 percent in 2005 (IFIC, 2005). Nearly 90 percent of those who strongly agree that foods can provide a health benefit beyond basic nutrition are eating a certain food for a specific health benefit.

As consumers increasingly turn to food as a way to improve their health and overall "well being", manufacturers are responding proactively with products which they hope will place them at the forefront of new product development. For this reason, functional foods have been rated second only to low fat foods as a key product development opportunity for the next five years (Hasler, 1998).

Prospects of the Functional Food Market

Recent quantitative research conducted by the International Food Information Council (IFIC, 2005) revealed that consumers strongly believe in the health promoting benefits of functional foods and they are becoming increasingly aware of the link between diet and health. If consumer interest continues, this sector is set to become a prime category for optimum growth and success. In addition, increased consumer understanding of the relationship between diet and health is driving demand for added value food products that provide a health benefit beyond basic nutrition. It also revealed that 90 percent of consumers were aware of a link between a specific food and its associated health benefits. Awareness of these foods was found to be higher for women than man (94 percent versus 89 percent).

Given that consumers are becoming increasingly proactive about their health and are looking to the food industry to develop products that will prevent disease, the future for functional foods seems optimistic. Future potential is however, dependent upon consumer acceptance of their efficiency, safety and sensory quality. In particular, the latter factor is an essential requirement in the highly competitive added value dairy market. It is clear that reliable scientific evidence to vindicate health claims will be required to enhance consumer confidence and subsequent acceptance of functional foods.

Plant Sterol

Plant sterols, or so-called phytosterol, are helpful in reducing blood cholesterol levels, one of the major risk factors of heart disease. Through clinical research, phytosterols also have been found to: (1) reduce symptoms of an enlarged prostate; (2) improve the control of blood sugar among people with diabetes; and (3) reduce inflammation among patients with autoimmune diseases such as rheumatoid arthritis and lupus. Plant sterols, found for example in fortified foods and beverages, including table spreads, juices, and yogurt for reduced risk of heart disease.

The first phytosterol-enriched product, Benecol margarine was first launched in Finland in 1995 and introduced to the United States in 1999 followed by

Take Control margarine. Minute Maid Heartwise was launched in October 2003 and Yoplait Heart Healthy in December 2004. Phytosterol-enriched products currently in the marketplace also include Nature Valley granola bar, Sara Lee Healthy Heart bread, Kellogg's Smart Start cereal and more. With the introduction of these new formats, the market of phytosterol-enriched products appears to have gained fresh momentum. ACNielsen reported that the total market for products with plant sterol claims arrived at $66 million in 2004 and $93 million for the year ended August 2005, up 28 per cent and 41 per cent from 2003, respectively.

Although consumer awareness of long-held associations between food and health remains high (IFIC, 2005), Americans are less aware that plant sterols help reduce the risk of heart disease. Specifically, only 30 percent consumers (154 out of 519) are aware of the relationship, second lowest among all the functional foods. In the meantime, 47 percent consumers are already consuming the phytosterol-enriched products. However, suppliers of sterol ingredients interviewed by Nutrition Business Journal (NBJ) suggested that while the market for sterols is going strong in Europe, Australia and elsewhere, in the US it is suffering from an acute shortage of consumer education and a lack of awareness in the medical community. According to AC Nielsen, the sterol foods market in Europe is estimated at $600 million and in Japan at $130 million (Functional Foods and Neutraceuticals, 2006).

Objective

To successfully launch functional foods, it is essential to obtain information on how current functional food products in the market are performing. This information can be used as a guide in current marketing and product development programs (Capps and Schmitz, 1991). Recent studies indicate that consumer research within the functional food sector is still in its infancy and further research is recommended to understand consumer needs, attitudes and perceptions more fully (Childs and Poryzees, 1998; Bogue and Ryan, 2000). Understanding consumers' attitudes, awareness and interest in functional foods are also important for professionals and manufacturers so that they can communicate better with consumers on food and nutrition information.

The objective of this study therefore is to assess the demand for and market behavior of functional foods in the categories of margarine, orange juice and yogurt categories. Specifically, the objectives of this dissertation are: (1) to estimate own-price elasticities of the phytosterol-enriched food products and of comparative products; and (2) to estimate cross-price elasticities of phytosterol-enriched products and to determine substitutability, complementarity and cannibalization of comparative products; (3) to propose a new methodology to identify cannibalization effects and (4) to examine the welfare effects of the introduction of new products.

The dissertation is organized as follows. The current chapter, Chapter I serves as an overview of functional foods. Chapter II briefly depicts the demand theory and the empirical model used. Chapters III, IV, and V are related but written from different perspective. Therefore they are self-contained papers embodying introduction, literature review, data descriptions, methodology and conclusion. The concluding chapter, Chapter VI, provides summaries and discussions with respect to the overall work.

CHAPTER II

THEORETICAL MODEL

Brief Introduction of Demand Theory

Classical demand theory is concerned with the behavior of an individual consumer who is assumed to have a stable preference system, which can be represented by a utility function

(2.1) $$u(q) = u(q_1, q_2, ..., q_n)$$

where n denotes the number of goods in the consumer's preference system, q_i is the quantity of the i^{th} good which may be bought and consumed by the consumer during the period of time being considered, and q is a vector of those quantities for all n goods. The function $u(\cdot)$ in equation (2.1) measures the amount of satisfaction the consumer enjoys from buying the bunch of goods, q_1 of the first good, q_2 of the second good, and so on. Then the consumer wishes to select the particular commodity basket, which maximizes the utility function (2.1), subject to a budget constraint

(2.2) $$\sum_{i=1}^{n} p_i q_i = m$$

which leads to the system of Marshallian demand equations

(2.3) $$q_i = f(m, p_1, p_2, ..., p_n) \qquad i = 1,2,\ldots,n$$

where m is the amount of total expenditure on the n goods and p_1, p_2, …, p_n are the prevailing prices of those goods.

Since classical demand theory implies several restrictions on equation (2.3), it is worthwhile considering the logarithmic differential version of this demand system, expressed in terms of elasticities. The logarithmic differential of equation (2.3) is

(2.4) $$d \ln q_i = \eta_i d \ln m + \sum_{j=1}^{n} \eta_{ij} d \ln p_j \qquad i = 1,2,\ldots,n$$

where η_i is the income elasticity of demand for the i^{th} good, and η_{ii} is the uncompensated, own-price elasticity, while the η_{ij} $(i \neq j)$ are the cross-price elasticities.

Some of the restrictions, which demand theory places on these elasticities can be expressed in terms of the budget shares

(2.5) $$w_i = \frac{p_i q_i}{m} \qquad i = 1,2,\ldots,n$$

which sums to unity

(2.6) $$\sum_{i=1}^{n} w_i = 1$$

and the compensated price elasticities, denoted by η_{ij}^* ,where

(2.7) $$\eta_{ij}^* = \eta_{ij} + \eta_i w_j \qquad i = 1,2,\ldots,n$$

The first set of restrictions on the elasticities are derived from the adding-up conditions, which require that the levels of demand for the various goods which are predicted by the demand system conditional on the values assumed by income and prices, satisfy the budget constraint equation (2.2).

The restrictions are

(2.8) $$\sum_{i=1}^{n} w_i \eta_i = 1$$

(2.9) $$\sum_{i=1}^{n} w_i \eta_{ij} = -w_j$$

and

(2.10) $$\sum_{i=1}^{n} w_i \eta_{ij}^{*} = 0$$

The homogeneity conditions are

(2.11) $$\sum_{j=1}^{n} \eta_{ij} = -\eta_i \qquad i = 1,2,\ldots,n$$

(2.12) $$\sum_{j=1}^{n} \eta_{ij}^{*} = 0 \qquad i = 1,2,\ldots,n$$

Another important property is that of "Slutsky symmetry"

(2.13) $$w_i e_{ij} = w_j e_{ji} \qquad i = 1,2,\ldots,n$$

Finally, there is "negativity" condition

(2.14) $$\sum_{i=1}^{n} \sum_{j=1}^{n} x_i w_i e_{ij} x_j \leq 0$$

Many early empirical demand studies approximated the demand equation (2.3) by double logarithmic specifications with constant elasticities (Duffy, 2001). While demand system based on this specification could fit the data quite well and yield plausible estimates of the elasticities, they are not well suited to the task of investigating the restrictions of classical demand analysis (Deaton and Muellbauer, 1980).

The Barten Model

The choice of demand systems potentially can have a notable effect on the estimation of elasticities. There are a large number of alternative models, which can be used to estimate these elasticities. One way of choosing among these models is the extent to which they satisfy the three major implications of the utility-maximizing theory of the consumer. That is, demand functions should conform with the budget constraint that the sum of expenditures on each good be equal to the exogenously-given total expenditure; they should also be homogeneous of degree zero in money income and prices; and the matrix of compensated price slopes should be symmetric negative semi-definite. But the number of demand models satisfying these conditions is still quite large.

Another way of proceeding is to use the concept of flexibility of demand models (Diewert, 1971). A demand model is said to be flexible if it is derived from a utility (or expenditure) function, which is a second-order approximation to an arbitrary function. Several demand systems including Barten (1964) and Theil's (1965) Rotterdam model and its several variants; the Translog Demand system (TLDS) utility function of Christensen et al. (1975); and Deaton and Muellbauer's (1980) Almost Ideal Demand System (AIDS) continue to enjoy considerable popularity among applied economists. In fact, the use of Rotterdam and Almost Ideal Demand System (AIDS) is very common in demand system estimation using scanner data (Capps, Seo and Nichols, 1997; Nayga and Capps, 1994; Seo and Capps, 1997).

However, there is little to guide a researcher when attempting to choose a particular functional form from among the set of alternatives. One of the compelling features of their specifications is that they maintain flexibility while satisfying the adding-up, homogeneity and symmetry restrictions in accord with demand theory at the same time. Barten (1993) shows that 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), may have desirable attributes.

As Barten (1993) states, there are basically four approaches to arrive at demand equations satisfying the desired properties. The first one starts off from the maximization of the utility function subject to the budget constraints (e.g., Linear Expenditure System). The second approach starts off from an indirect utility function and applies Roy's Identity (e.g., Indirect Translog Utility functions). The third approach starts from an expenditure function, and the application of Shephard's Lemma results in Hicksian demand equations. A well-known example is Almost Ideal Demand System (AIDS). Its expenditure function that is price independent generalized logarithm (PIGLOG) reads

(2.15) $$\ln e(u,p) = \ln a_0 + \sum_i a_i \ln p_i + \frac{1}{2}\sum_i \sum_j r_{ij} \ln p_i \ln p_j + u\prod_j p_j^{c_j}$$

The application of Shephard's Lemma yields

(2.16) $$w_i = a_i + c_i u \prod_j p_j^{c_i} + \sum_j r_{ij} \ln p_j$$

The unobservable utility level is eliminated by using the expenditure function, and we get

(2.17) $$w_i = a_i + c_i(\ln m - \ln P^*) + \sum_j r_{ij} \ln p_j$$

where

(2.17a) $$\ln P^* = \sum_k w_k \ln p_k$$

which is often referred to as Stone Index. By totally differentiating equation (2.17) in both sides, we obtain the first difference AIDS,

(2.18) $$dw_i = c_i d \ln Q + \sum_j r_{ij} d \ln p_j$$

A specific example of the fourth approach is Rotterdam (Theil, 1960). Maximizing the utility function (2.1) $U = U(q_1, q_2, ..., q_n)$ subject to budget constraint (2.2) $\sum_i p_l q_i = m$ yields the Marshallian demand

(2.3) $$q_i^* = q_i(q_1, q_2, ..., q_n, m)$$

Total differentiation and transformation of equation (2.3) gives

(2.19) $$d \ln q_i = \sum_j \mu_{ij} d \ln p_j + \eta_i d \ln m$$

By substituting the Slutsky $s_{ij} = \mu_{ij} + \eta_i w_j$ in equation (2.19), we have the Rotterdam Model

(2.20) $$\begin{aligned} d \ln q_i &= \sum_j w_i s_{ij} d \ln p_j + \eta_i w_i \left(d \ln m - \sum_j w_j d \ln p_j\right) \\ &= \sum_j c_{ij} d \ln p_j + b_i d \ln Q \end{aligned}$$

Keller and van Driel (1985) of the Dutch Central Bureau of Statistics (CBS) created a hybrid of AIDS and Rotterdam system,

(2.21) $$w_i(d \ln q_i - d \ln Q) = \sum_j s_{ij} d \ln p_j + c_i d \ln Q$$

Neves (1987) proposed the NBR system,

(2.22) $$dw_i + w_i d\ln Q = \sum_j r_{ij} d\ln p_j + b_i d\ln Q$$

This is another hybrid system because it has the Rotterdam income coefficients and the AIDS price coefficients.

Barten (1993) created a synthetic model which nests the above four demand systems. The Barten model is specified as follows:

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

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 denotes expenditure share of i^{th} product and p_j denotes price of j^{th} product. 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. The theoretical demand restrictions pertaining to homogeneity, symmetry and adding-up are the following:

(2.24a) $\sum_j c_{ij} = 0 \ \forall$ i (homogeneity)

(2.24b) $c_{ij} = c_{ji} \forall$ *i* and *j* (symmetry)

(2.24c) $\sum_j c_{ij} = 0 \ \forall \ j$ (adding-up)

(2.24d) $\sum_i b_i = 1 - \delta$ (adding-up).

The formula for the income elasticities, uncompensated and compensated price elasticities for the alternative models are presented in Table 1. In terms of income elasticities, the sign of c_i determines whether the good is luxury, necessity or inferior good in AIDS and CBS models (Neves, 1994). Although inferior good is rarely observed in empirical work, the constraint is still too restrictive. For the Barten (1993) model, the income elasticity depends not only on the signs of c_i but also the magnitude of δ, allowing it to be more flexible.

Table 1. Comparison of Elasticities across Demand Systems

Model	Income	Uncompensated (η_{ij})	Compensated (η_{ij}^*)
Rotterdam	$\frac{b_i}{w_i}$	$\frac{c_{ij} - b_i w_j}{w_i}$	$\frac{c_{ij}}{w_i}$
AIDS	$1+\frac{c_i}{w_i}$	$\frac{r_{ij} - c_i w_j}{w_i} - \delta_{ij}$	$\frac{r_{ij}}{w_i} + w_j - \delta_{ij}$
CBS	$1+\frac{c_i}{w_i}$	$\frac{s_{ij} - (c_i + w_i) w_j}{w_i}$	$\frac{s_{ij}}{w_i}$
NBR	$\frac{b_i}{w_i}$	$-b_i \frac{w_j}{w_i} + \frac{r_{ij}}{w_i} + w_j - \delta_{ij}$	$\frac{r_{ij}}{w_i} + w_j - \delta_{ij}$
Barten (1993)	$\delta + \frac{b_i}{w_i}$	$\frac{c_{ij} - \gamma w_i (\delta_{ij} - w_j)}{w_i} - w_j \frac{b_i + \delta w_i}{w_i}$	$\frac{c_{ij}}{w_i} + \gamma w_j - \gamma \delta_{ij}$

The compensated cross-price elasticities for Rotterdam and CBS models ($i \neq j$) are too restrictive because it requires that the two goods are net substitutes or net complements namely, either $c_{ij}(s_{ij}) > 0$ or $c_{ij}(s_{ij}) < 0$ all through the sample period (Neves, 1994). The assumption of AIDS and NBR in this regard is less restrictive because the compensated elasticities depend on $r_{ij} + w_i w_j$ and it is allowed to vary during the study period. Barten (1993) is even more flexible in that it adds an additional variable γ.

We would also like to examine how the own price elasticities ($i = j$) change for these five models with the change of expenditure shares. If the market share for a good increases monotonically in the period, the own uncompensated elasticities in Rotterdam are restricted to increase over time as long as $\varepsilon_{ii} < 0$, which often times is the case. This result also applies to the compensated own price elasticities in Rotterdam and CBS models. From this perspective, AIDS and NBR are more plausible and Barten (1993) allows more flexibility in this regard.

Furthermore, the Barten (1993) allows for the formal tests of the functional forms of Rotterdam, LA/AIDS, CBS and NBR, which are reduced to the tests of parameter (δ and γ) values. In sum, the Barten (1993) model is more appealing and should be preferred in general over the four nested models.

CHAPTER III

ASSESSING THE DEMAND FOR FUNCTIONAL FOODS: THE CASE OF PHYTOSTEROL-ENRICHED MARGARINE

Evidence exists in the literature that health related concerns have had an influence on decisions by consumers to reduce consumption of harmful ingredients (i.e., fats, salt) or to increase consumption of beneficial components into their diets (Brown and Schrader, 1990; Chang and Kinnucan, 1991; Skaggs, Menkhaus, Torok, and Field, 1987). Consequently, functional foods have become increasingly popular in recent years. Defined as foods or food components that may provide a health benefit beyond basic nutrition, functional foods are widely believed to offer consumers an increased ability to reduce the risk of certain diseases or health problems (Schmidt, 2000). Many food companies now are developing food products with functional or health-related attributes. Research conducted by the International Food Information Council (IFIC) shows that consumer demand for functional foods has steadily increased since 1996. Hasler (1998) also rated functional foods highly, second only to low fat foods as a key product development opportunity.

To successfully launch functional foods, it is essential to obtain information on how current functional food products in the market are performing. This information can be used as a guide in current marketing and product development programs (Capps and Schmitz, 1991). For example, food manufacturers and retailers would be interested in questions such as:

(1) Does the market view a functional food product as a differentiated product vis-à-vis other products within the same product category?

(2) Do functional food products command a premium price?

(3) How sensitive is the demand for functional foods to changes in price?

(4) How sensitive is the demand for functional foods to changes in prices of other competing products?

(5) How substitutable is a functional food product with other products within the same product category?

Recent studies indicate that consumer research within the functional food sector still is in its infancy and further research is recommended to understand consumer needs, attitudes and perceptions more fully (Bogue and Ryan, 2000; Childs and Poryzees, 1998). The objective of this study therefore is to assess the demand for and market behavior of functional foods. We look at the case of the margarine product category because it contains two products with a functional or health-related attribute: phytosterol.

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: (1) reduce symptoms of an enlarged prostate; (2) improve the control of blood sugar among people with diabetes; and (3) reduce inflammation among patients with autoimmune diseases such as rheumatoid arthritis and lupus. Consequently, there has been an increased interest in incorporating phytosterols in food products.

We also use margarine because it is currently the dominant product category in the phytosterol-enriched products market (Hilliam, 2001). Two phytosterol-enriched products in the margarine category exist, namely, Benecol and Take Control. The first phytosterol-enriched margarine product introduced in the marketplace by the Raisio Group in Finland in 1995 was Benecol. Unilever then followed suit in 1999 with its own brand of phytosterol-enriched margarine, Take Control.

We employ weekly scanner data from Information Resources Inc. (IRI) over the period August 11, 2003 to September 4, 2005. Using the flexible Barten (1993) synthetic demand system, we estimate the own-price elasticities for phytosterol-enriched margarine brands and non-phytosterol margarine brands to assess consumer sensitivity to price changes. We also estimate cross-price elasticities of phytosterol-enriched food products, within the margarine category to determine substitutability among the products. Our findings generally indicate that the market views the phytosterol-enriched products differently from other "regular" brands. Our results also indicate that substantial price premiums exist for Benecol and Take Control. Despite commanding notable premiums, their own-price elasticities are remarkably not the highest in the product category. Cross-price elasticities also suggest that consumers tend to treat Benecol and Take Control separately from the other margarine brands. We also used the estimated demand system, along with a Nash-Bertrand model of competition to indirectly estimate the price effects of the introduction of the phytosterol-enriched products on existing brands. Results generally suggested that the price effects on existing brands due to the introduction of phytosterol-enriched products are small.

The remainder of the paper is organized as follows. In the next section, we briefly discuss the theoretical framework and empirical model. The following section describes the data and descriptive statistics. The next section discusses the empirical results. Finally, a summary of the findings and recommendations for further research are presented.

Theoretical Framework and Empirical Model

The theoretical framework we use is similar to the work of (Basmann, 1956) in conjunction with consumer demand with variable preferences.

The utility function can be expressed as

$$U = U(q; g(r)) \tag{3.1}$$

where q represents the commodity vector and $g(r)$ represents consumer preferences for given state variables r. The state variables r correspond to stock of knowledge, psychological stock of habits or physical stock of goods (Capps and Schmitz, 1991). In the case of health and nutrition, the vector r may consist of scientific information pertaining to a health attribute or ingredient such as phytosterol or a health claim. The key assumption with regard to this study is that changes in health and nutrition information lead to changes in consumer preferences $g(r)$ for the commodity vector q, which in turn gives rise to changes in the parameters of the utility function. Subsequently, maximization of the utility function with respect to q, given r, subject to the budget constraint

(3.2) $\sum_i p_l q_i = m$

yields Marshallian demand functions in the form

(3.3) $q_t = q_t(m, p; r_t)$

Consumer demand relationships depend not only on prices and income but also state variables.

To derive the own-price, cross-price and expenditure elasticities, we employ a demand-system approach. Barten (1993) created a synthetic model which nests popular differential demand systems including the Rotterdam, LA/AIDS, CBS (Central Bureau of Statistics) and NBR (National Bureau Research). The Barten model is specified as follows:

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

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 denotes expenditure share of i^{th} product and p_j denotes price of j^{th} product.

The theoretical demand restrictions pertaining to homogeneity, symmetry and adding-up are the following:

(3.5a) $\sum_j c_{ij} = 0$ $\forall$ i (homogeneity)

(3.5b) $c_{ij} = c_{ji}$ $\forall$ *i* and *j* (symmetry)

(3.5c) $\sum_j c_{ij} = 0 \ \forall \ j$ (adding-up)

(3.5d) $\sum_i b_i = 1 - \delta$ (adding-up).

The Barten (1993) allows for the formal tests of the functional forms of Rotterdam, LA/AIDS, CBS and NBR, which are reduced to the tests of the parameters, δ and γ . In sum, the Barten (1993) model is more appealing and encompassing over the four nested models.

Data and Descriptive Statistics

The data consist of weekly sales and volume information on margarine products obtained from Information Resources, Inc. (IRI). The margarine category covers 295 Universe Product Codes (UPC) from August 11, 2003 to September 4, 2005 for a total of 108 weekly observations. Multicollinearity, degrees of freedom issues, and computational limitations necessitate aggregation across UPCs. Therefore, we aggregate these UPCs into 13 different brands, namely, (1) Benecol, (2) Take Control, (3) Blue Bonnet, (4) Fleischmann's, (5) I Can't Believe It's Not Butter, (6) Imperial, (7) Land O' Lakes, (8) Parkay, (9) Promise, (10) Shedd's, (11) Smart Balance, (12) Private Label, (13) all other branded margarine. Prices for each brand are weighted average prices, calculated by dividing the total dollar sales by the volume sales for each brand in each time period. Benecol and Take Control are the phytosterol-enriched products in this analysis.

As exhibited in Table 2, Benecol and Take Control have the highest average prices, $9.43 and $7.04 per pound, respectively. For the remaining brands, the average price ranges from $0.64 per pound (Private Label) to $2.00 per pound (Smart Balance). Consequently, a considerable premium on price exists for phytosterol-enriched products relative to products containing no phytosterols.

As given in Table 3, Shedd's and I Can't Believe It's Not Butter are the leaders of the margarine category in terms of average sales, roughly $4.0 million to $4.5 million per week. The average weekly sales of Benecol and Take Control are comparable with each other at close to $400,000. This figure is on par with the average weekly sales of Promise. The sales of remaining margarine brands, on average, range from about $185,000 (Private Label products) to $960,000 (Fleischmann's).

Table 2. Descriptive Statistics of Prices, August 2003 to September 2005 ($/pound)

Brand	Mean	Std Dev	Min	Median	Max
Benecol	9.43	0.24	8.02	9.42	9.83
Take Control	7.04	0.13	6.71	7.10	7.22
Blue Bonnet	0.68	0.04	0.53	0.68	0.76
Fleischmann's	1.50	0.12	1.18	1.51	1.71
I Can't Believe It's Not Butter	1.89	0.10	1.52	1.91	2.02
Imperial	0.72	0.06	0.55	0.73	0.82
Land O' Lakes	1.80	0.10	1.53	1.81	2.00
Parkay	1.22	0.05	1.10	1.22	1.32
Promise	1.95	0.09	1.61	1.94	2.12
Shedd's	0.93	0.08	0.75	0.96	1.04
Private Label	0.64	0.02	0.59	0.65	0.69
Smart Balance	2.00	0.08	1.83	2.01	2.18
All Other Brands	1.22	0.13	0.96	1.27	1.36

Table 3. Descriptive Statistics of Sales over the Period August 2003 to September 2005 ($)

Brand	Mean	Std Dev	Min	Median	Max
Benecol	393,350	35,584	296,699	397,980	473,302
Take Control	380,556	42,843	292,680	380,640	476,217
Blue Bonnet	1,577,764	358,424	1,113,199	1,470,673	2,711,556
Fleischmann’s	957,265	171,101	738,416	908,089	1,525,481
I Can’t Believe It’s Not Butter	4,059,859	1,351,629	1,684,474	4,626,737	6,705,406
Imperial	1,108,731	253,852	809,577	1,025,440	1,956,105
Land O’ Lakes	1,831,111	235,429	1,251,846	1,820,594	2,493,240
Parkay	1,752,093	298,625	1,285,241	1,686,547	2,788,292
Promise	392,705	39,964	302,919	391,232	589,864
Shedd’s	4,544,809	650,821	3,187,527	4,635,407	6,186,220
Private Label	1,854,201	187,862	1,450,473	1,859,530	2,278,223
Smart Balance	1,351,586	250,256	830,490	1,367,471	1,974,619
All Other Brands	1,721,144	353,881	1,001,697	1,869,153	2,237,201

Average weekly volume figures are presented in Table 4. Volumes are highest for Shedd’s by far at close to five million pounds, followed by Private Label products (close to three million pounds). The average volumes of Blue Bonnet, and I Can’t Believe It’s Not Butter are slightly more than two million pounds; weekly volumes of Take Control and Benecol, on average, are roughly 54,000 and 42,000 pounds, respectively.

Table 4. Summary Statistics of Quantity (Volume), August 2003 to September 2005 (Pounds)

Brand	Mean	Std Dev	Min	Median	Max
Benecol	41,786	4,558	30,640	42,051	54,673
Take Control	54,199	6,912	40,678	53,618	68,969
Blue Bonnet	2,375,283	712,001	1,516,669	2,150,452	5,144,440
Fleischmann’s	651,140	171,253	455,631	593,561	1,266,797
I Can’t Believe It’s Not Butter	2,154,084	755,041	848,820	2,404,785	4,415,466
Imperial	1,576,215	506,568	1,041,358	1,416,106	3,491,884
Land O’ Lakes	1,018,413	143,077	760,418	998,929	1,402,613
Parkay	1,446,134	299,441	1,003,474	1,362,601	2,510,140
Promise	202,560	27,767	145,635	201,946	366,093
Shedd’s	4,880,754	525,865	3,851,173	4,860,076	6,311,866
Private Label	2,887,946	348,389	2,219,515	2,852,341	3,749,613
Smart Balance	672,768	113,562	436,937	675,351	972,642
All Other Brands	1,403,584	189,745	951,317	1,416,817	1,861,716

As exhibited in Table 5, the average market shares of Benecol and Take Control are 1.83% and 1.78%, respectively. The category leaders in terms of market shares are Shedd’s and I Can’t Believe It’s Not Butter.

Table 5. Summary Statistics of Market Shares by Brand over the Period August 2003 to September 2005 (%)

Brand	Mean	Std Dev	Min	Median	Max
Benecol	1.83	0.34	1.25	1.72	2.73
Take Control	1.78	0.39	1.17	1.63	2.61
Blue Bonnet	7.19	1.20	5.65	6.86	11.01
Fleischmann’s	4.41	0.80	3.47	4.10	7.50
I Can’t Believe It’s Not Butter	18.10	4.74	8.89	20.60	24.56
Imperial	5.08	0.98	3.90	4.65	8.32
Land O’ Lakes	8.38	0.60	6.91	8.30	10.06
Parkay	8.10	1.59	6.31	7.31	12.81
Promise	1.83	0.32	1.34	1.70	2.71
Shedd’s	20.73	0.99	17.93	20.86	22.94
Private Label	8.61	1.50	6.40	8.01	12.14
Smart Balance	6.16	0.79	4.79	6.07	7.74
All Other Brands	7.79	0.91	5.65	8.24	8.91

Results

Demand Elasticities

Theoretical restrictions (equations (3.5a) to (3.5d)) are imposed in the estimation. In estimating the Barten (1993) demand system, one equation is dropped to avoid estimation problems due to the singularity of the variance-covariance matrix of disturbance terms. So, our demand system consists of twelve equations with the category "all other brands" omitted. An Iterated Seemingly Unrelated Regression (ITSUR) technique is applied taking into account the contemporaneous correlation of the disturbance terms among the equations. We also allow for the presence of an AR (1) serial correlation process in the disturbance term of the demand system.

The estimated coefficients, standard errors, t-statistics, and goodness-of-fit statistics associated with the estimation of the Barten demand model are presented in Table 6. The results associated with functional form tests suggest that the generalized Barten model statistically is superior to the Rotterdam model, the LA/AIDS model, the CBS model, and the NBR model.

Table 6. Parameter Estimates, Standard Errors, p-values and Goodness-of-Fit Statistics for the Synthetic Barten Model

	Durbin-Watson	R-Squared
Benecol Equation	1.993	0.555
Take Control Equation	1.926	0.232
Blue Bonnet Equation	1.526	0.911
Fleischmann's Equation	1.902	0.891
I Can't Believe It's Not Butter Equation	1.438	0.849
Imperial Equation	1.765	0.925
Land O' Lakes Equation	1.773	0.697
Parkay Equation	1.752	0.805
Promise Equation	2.073	0.824
Shedd's Equation	2.012	0.881
Private Label Equation	1.865	0.746
Smart Balance Equation	1.833	0.445

Coefficient	Estimates	St. Error	p-value
b_1	-0.009	0.003	0.004
$c_{1,1}$	0.010	0.005	0.072
$c_{1,2}$	0.010	0.003	0.004
$c_{1,3}$	-0.003	0.002	0.071
$c_{1,4}$	0.001	0.002	0.665
$c_{1,5}$	-0.005	0.003	0.058
$c_{1,6}$	-0.002	0.002	0.132
$c_{1,7}$	-0.002	0.003	0.409
$c_{1,8}$	-0.001	0.003	0.775
$c_{1,9}$	0.002	0.001	0.276
$c_{1,10}$	-0.013	0.003	0.000
$c_{1,11}$	0.001	0.004	0.805
$c_{1,12}$	0.001	0.004	0.812

Table 6. Continued

Coefficient	Estimates	St. Error	p-value
Delta	0.946	0.155	0.000
Gamma	2.677	0.193	0.000
b_2	-0.009	0.003	0.003
$c_{2,2}$	0.014	0.006	0.016
$c_{2,3}$	-0.004	0.002	0.006
$c_{2,4}$	-0.001	0.001	0.692
$c_{2,5}$	-0.003	0.002	0.261
$c_{2,6}$	0.000	0.001	0.777
$c_{2,7}$	-0.002	0.003	0.420
$c_{2,8}$	0.001	0.003	0.787
$c_{2,9}$	0.000	0.001	0.965
$c_{2,10}$	-0.014	0.003	0.000
$c_{2,11}$	0.003	0.003	0.412
$c_{2,12}$	-0.002	0.003	0.559
b_3	0.023	0.013	0.063
$c_{3,3}$	0.017	0.014	0.241
$c_{3,4}$	0.003	0.004	0.344
$c_{3,5}$	-0.017	0.010	0.071
$c_{3,6}$	0.011	0.004	0.007
$c_{3,7}$	0.005	0.006	0.395
$c_{3,8}$	0.006	0.007	0.363
$c_{3,9}$	0.001	0.002	0.497
$c_{3,10}$	-0.014	0.008	0.092
$c_{3,11}$	0.000	0.006	0.979
$c_{3,12}$	0.002	0.007	0.763
b_4	-0.002	0.008	0.768
$c_{4,4}$	0.030	0.009	0.001
$c_{4,5}$	-0.009	0.007	0.158
$c_{4,6}$	-0.005	0.003	0.092
$c_{4,7}$	-0.005	0.005	0.370
$c_{4,8}$	-0.007	0.006	0.223
$c_{4,9}$	0.002	0.002	0.341

Table 6. Continued

Coefficient	Estimates	St. Error	p-value
$c_{4,10}$	-0.014	0.007	0.052
$c_{4,11}$	0.006	0.004	0.174
$c_{4,12}$	0.004	0.006	0.539
b_5	0.028	0.031	0.373
$c_{5,5}$	0.124	0.037	0.001
$c_{5,6}$	-0.015	0.007	0.036
$c_{5,7}$	-0.041	0.011	0.000
$c_{5,8}$	-0.021	0.012	0.097
$c_{5,9}$	-0.001	0.003	0.777
$c_{5,10}$	0.005	0.017	0.769
$c_{5,11}$	0.000	0.011	0.967
$c_{5,12}$	-0.011	0.011	0.320
b_6	0.015	0.009	0.095
$c_{6,6}$	0.036	0.010	0.000
$c_{6,7}$	-0.017	0.006	0.003
$c_{6,8}$	-0.001	0.006	0.836
$c_{6,9}$	0.003	0.002	0.095
$c_{6,10}$	0.003	0.007	0.676
$c_{6,11}$	0.007	0.005	0.129
$c_{6,,12}$	-0.009	0.006	0.143
b_7	-0.010	0.014	0.488
$c_{7,7}$	0.094	0.021	0.000
$c_{7,8}$	0.006	0.010	0.539
$c_{7,9}$	-0.002	0.004	0.605
$c_{7,10}$	-0.006	0.013	0.665
$c_{7,11}$	-0.005	0.009	0.598
$c_{7,12}$	-0.005	0.011	0.633

Table 6. Continued

Coefficient	Estimates	St. Error	p-value
b_8	0.019	0.015	0.204
$c_{8,8}$	0.037	0.019	0.054
$c_{8,9}$	-0.002	0.004	0.518
$c_{8,10}$	-0.001	0.012	0.947
$c_{8,11}$	0.006	0.009	0.514
$c_{8,12}$	-0.022	0.010	0.033
b_9	-0.001	0.003	0.669
$c_{9,9}$	0.007	0.004	0.085
$c_{9,10}$	-0.009	0.004	0.017
$c_{9,11}$	0.000	0.004	0.917
$c_{9,12}$	0.003	0.004	0.496
b_{10}	0.025	0.033	0.447
$c_{10,10}$	0.113	0.040	0.005
$c_{10,11}$	-0.016	0.011	0.146
$c_{10,12}$	-0.009	0.013	0.505
b_{11}	0.001	0.014	0.957
$c_{11,11}$	0.023	0.020	0.252
$c_{11,12}$	0.005	0.010	0.630
b_{12}	-0.021	0.011	0.057
$c_{12,12}$	0.053	0.019	0.005
ρ	-0.249	0.030	0.000

Notes: 1. SHAZAM 9.0 is used to estimate the Barten (1993) model.

2. ρ refers to the autocorrelation coefficient.

3. The estimated coefficients b_i's and $c_{i,j}$'s are corresponding to equation 1. Subscript 1 represents Benecol, 2 refers to Take Control, 3 represents Blue Bonnet, 4 denotes Fleischmann's, 5 denotes I Can't Believe It's Not Butter, 6 refers to Imperial, 7 represents Land O' Lakes, 8 denotes Parkay, 9 refers to Promise, 10 denotes Shedd's, 11 represents Private Label and 12 refers to Smart Balance. For example, c_{12} refers to the effects of Take Control on the demand of Benecol.

The estimates of the uncompensated and compensated price elasticities and the p-values associated with the elasticities are reported in Tables 7 to 8. As given in Table 7, the uncompensated own-price elasticities range from -1.08 (all other brands) to -2.34 (Blue Bonnet). Similarly, the compensated own-price elasticities, shown in Table 8, range from -1.01 (all other brands) to - 2.25 (Blue Bonnet). These measures suggest that the demands for margarine brands are elastic. Simply put, consumers are very sensitive to price changes. Own-price elasticities also partly reflect the strength of the brand or product in the category. It is interesting to note that top two brands in terms of market share, Shedds and I Can't Believe it's not Butter, do not have the lowest own-price elasticities. This honor belongs to "all other brands" and Land O' Lakes. Hence, these results may signify that Land O' Lakes is generally considered a relatively strong brand in the margarine category. The own-price elasticity of "all other brands" seems relatively low, but this representation corresponds to an aggregate product. Despite the salient premiums that the phytosterol-enriched products command, it is quite remarkable that they do not exhibit the highest own-price elasticities in the margarine category. This finding may reflect the relative strength of Benecol and Take Control and of the value of the phytosterol attribute in these products. The products with the highest own-price elasticities are Blue Bonnet, Promise, and Private Labels. The expenditure elasticities range from 0.46 (Take Control) to 1.27 (Blue Bonnet). In fact, the expenditure elasticities for the phytosterol products are very similar, and they are the lowest of the margarine brands. Consequently, phytosterol enriched margarine products benefit the least when total expenditure rises in the margarine category. This result is expected considering the premiums that these products command and the relatively small market share (less than 2 percent each) of these two products.

As exhibited in Table 8, given that most of the off-diagonal elements are positive, the brands in the margarine category largely are substitutes. These off-diagonal elements correspond to compensated cross-price elasticities. For the phytosterol products, the most significant competitor for Benecol is Take Control and vice-versa. The only other statistically significant competitor for Benecol is “all other brands” but the magnitude of this cross-price elasticity is smaller than that of Take Control. In the case of Take Control, its other statistically significant competitors albeit, with smaller cross-price elasticities, are I Can’t Believe It’s Not Butter and Private Label products. Given the fact that Benecol and Take Control are much more expensive than other margarine products and that they have strong substitution effects between each other, it is logical to assume that consumers purchase these two brands because of their phytosterol content or in accord with the health claim, “to reduce blood cholesterol levels”.

Table 7. Uncompensated Own-Price, Cross-Price, and Expenditure Elasticities Associated with the Brands

	Benecol	*Take Control*	*Blue Bonnet*	*Fleisch-mann's*	*I Can't Believe Its Not Butter*	*Imperial*	*Land O' Lakes*
Benecol	-2.099	0.572	-0.013	0.133	0.116	-0.021	0.050
	(0.000)	(0.002)	(0.889)	(0.097)	(0.422)	(0.812)	(0.756)
Take Control	0.589	-1.839	-0.079	0.069	0.252	0.092	0.066
	(0.002)	(0.000)	(0.339)	(0.328)	(0.048)	(0.200)	(0.651)
Blue Bonnet	-0.018	-0.034	-2.341	0.109	0.014	0.224	0.191
	(0.455)	(0.101)	(0.000)	(0.026)	(0.913)	(0.000)	(0.023)
Fleischmann's	0.047	0.020	0.204	-1.924	0.111	-0.022	0.047
	(0.161)	(0.485)	(0.010)	(0.000)	(0.444)	(0.737)	(0.674)
I Can't Believe Its Not Butter	0.000	0.013	0.018	0.018	-1.706	-0.004	-0.095
	(0.994)	(0.303)	(0.724)	(0.622)	(0.000)	(0.920)	(0.100)
Imperial	-0.022	0.018	0.320	-0.035	-0.041	-1.901	-0.219
	(0.500)	(0.477)	(0.000)	(0.547)	(0.774)	(0.000)	(0.047)
Land O' Lakes	0.004	0.007	0.196	0.028	-0.156	-0.112	-1.401
	(0.903)	(0.811)	(0.006)	(0.638)	(0.201)	(0.091)	(0.000)
Parkay	0.016	0.036	0.182	-0.023	0.018	0.062	0.198
	(0.692)	(0.287)	(0.022)	(0.753)	(0.906)	(0.373)	(0.092)
Promise	0.120	0.035	0.207	0.173	0.274	0.272	0.051
	(0.136)	(0.595)	(0.059)	(0.074)	(0.128)	(0.011)	(0.797)
Shedd's	-0.032	-0.040	0.047	0.004	0.315	0.097	0.108
	(0.039)	(0.003)	(0.215)	(0.910)	(0.000)	(0.005)	(0.064)
Private Label	0.042	0.061	0.126	0.145	0.306	0.173	0.088
	(0.320)	(0.105)	(0.042)	(0.003)	(0.010)	(0.002)	(0.397)
Smart Balance	0.053	0.006	0.185	0.148	0.204	-0.046	0.090
	(0.392)	(0.913)	(0.110)	(0.105)	(0.210)	(0.651)	(0.611)
All Other	0.076	0.014	0.034	0.023	0.250	-0.034	-0.110
	(0.085)	(0.690)	(0.434)	(0.529)	(0.002)	(0.375)	(0.104)

Table 7. Continued

	Parkay	*Promise*	*Shedd's*	*Private Label*	*Smart Balance*	*All Other*	*Expenditure*
Benecol	0.128	0.127	-0.239	0.239	0.186	0.355	0.465
	(0.465)	(0.111)	(0.179)	(0.227)	(0.370)	(0.055)	(0.000)
Take Control	0.221	0.043	-0.337	0.340	0.029	0.095	0.457
	(0.145)	(0.519)	(0.028)	(0.063)	(0.875)	(0.537)	(0.000)
Blue Bonnet	0.197	0.045	0.094	0.123	0.117	0.007	1.272
	(0.031)	(0.109)	(0.408)	(0.101)	(0.246)	(0.887)	(0.000)
Fleischmann's	-0.019	0.071	0.054	0.288	0.189	0.040	0.893
	(0.889)	(0.078)	(0.733)	(0.003)	(0.146)	(0.542)	(0.000)
I Can't Believe Its Not Butter	0.014	0.024	0.355	0.133	0.039	0.091	1.099
	(0.837)	(0.207)	(0.000)	(0.023)	(0.503)	(0.012)	(0.000)
Imperial	0.093	0.091	0.358	0.269	-0.095	-0.080	1.244
	(0.410)	(0.019)	(0.013)	(0.005)	(0.450)	(0.177)	(0.000)
Land O' Lakes	0.219	0.012	0.317	0.101	0.052	-0.098	0.830
	(0.054)	(0.776)	(0.030)	(0.352)	(0.690)	(0.118)	(0.000)
Parkay	-2.104	-0.001	0.301	0.203	-0.184	0.120	1.176
	(0.000)	(0.981)	(0.044)	(0.071)	(0.158)	(0.095)	(0.000)
Promise	0.020	-2.264	-0.110	0.135	0.273	-0.057	0.871
	(0.917)	(0.000)	(0.575)	(0.493)	(0.254)	(0.685)	(0.000)
Shedd's	0.126	-0.013	-1.799	0.061	0.057	-0.001	1.069
	(0.026)	(0.435)	(0.000)	(0.224)	(0.361)	(0.981)	(0.000)
Private Label	0.209	0.027	0.171	-2.264	0.165	-0.204	0.955
	(0.046)	(0.514)	(0.160)	(0.000)	(0.174)	(0.005)	(0.000)
Smart Balance	-0.195	0.086	0.290	0.261	-1.693	0.011	0.601
	(0.249)	(0.225)	(0.170)	(0.121)	(0.000)	(0.000)	(0.000)
All Other	0.149	-0.014	0.037	-0.219	-0.009	-1.081	0.884
	(0.048)	(0.680)	(0.620)	(0.006)	(0.913)	(0.000)	(0.000)

Note: The figures in the parentheses are the corresponding p-values.

For the remaining brands, notable competitors are identified by compensated cross-price elasticities whose p-values are less than 0.05. The magnitude of the compensated cross-price elasticity yields the degree of substitutability if the sign is positive and the degree of complementarity if the sign is negative. Hence, in the case of Blue Bonnet margarine for example, the most salient competitors given in order of magnitude are Shedd's, Parkay, Land O' Lakes, Imperial, Private Label products, Fleischmann's, all other brands, and Promise. We also estimate the top-level demand equation to determine consumers' sensitivity to margarine prices as one commodity and to assess whether income has a significant influence on the demand for margarine products. To provide a general functional form, we apply a Box-Cox transformation of the dependent variable. A stone index is calculated from the brand level. The price index for the overall category of margarine is endogenous as suggested by Hausman test; therefore, an Instrumental Variable (IV) is applied. The lagged quantity, income, trend and seasonality are used as instruments to estimate the equation. It is hypothesized that the price elasticity of the overall category for margarine be no greater than the individual price elasticities of each brand due to less competition at the commodity level than at the brand level. Indeed, the estimated own price elasticity is substantially lower at -0.38. This estimate is consistent with previous research. For example, Gould, Cox, and Perali (1991) estimated the own-price elasticity of margarine to be -0.23. Yen and Chern (1992) estimated the price elasticity of corn oil at -0.55. Gould (1997) using household panel data estimated the own-price elasticity of margarine at -0.07.

Table 8. Compensated Own-Price, Cross-Price, and Expenditure Elasticities Associated with the Brands

	Benecol	*Take Control*	*Blue Bonnet*	*Fleisch-mann's*	*I Can't Believe Its Not Butter*	*Imperial*	*Land O' Lakes*
Benecol	-2.091 (0.000)	0.581 (0.002)	0.020 (0.829)	0.154 (0.058)	0.200 (0.175)	0.003 (0.974)	0.089 (0.582)
Take Control	0.598 (0.002)	-1.831 (0.000)	-0.046 (0.582)	0.089 (0.210)	0.334 (0.010)	0.115 (0.113)	0.105 (0.476)
Blue Bonnet	0.005 (0.829)	-0.011 (0.582)	-2.250 0.000	0.165 (0.001)	0.244 (0.058)	0.289 (0.000)	0.297 (0.000)
Fleischmann's	0.064 (0.058)	0.036 (0.210)	0.268 (0.001)	-1.885 (0.000)	0.273 (0.067)	0.023 (0.723)	0.122 (0.276)
I Can't Believe Its Not Butter	0.020 (0.175)	0.033 (0.010)	0.097 (0.058)	0.066 (0.067)	-1.507 (0.000)	0.052 (0.199)	-0.003 (0.964)
Imperial	0.001 (0.974)	0.040 (0.113)	0.409 (0.000)	0.020 (0.723)	0.184 (0.199)	-1.838 (0.000)	-0.114 (0.298)
Land O' Lakes	0.020 (0.582)	0.022 (0.476)	0.255 (0.000)	0.064 (0.276)	-0.006 (0.964)	-0.069 (0.298)	-1.331 (0.000)
Parkay	0.038 (0.346)	0.057 (0.089)	0.266 (0.001)	0.029 (0.687)	0.230 (0.130)	0.121 (0.083)	0.297 (0.012)
Promise	0.136 (0.089)	0.050 (0.442)	0.270 (0.015)	0.211 (0.030)	0.432 (0.019)	0.316 (0.003)	0.124 (0.517)
Shedd's	-0.013 (0.412)	-0.021 (0.110)	0.124 (0.001)	0.051 (0.417)	0.509 (0.000)	0.151 (0.000)	0.198 (0.001)
Private Label	0.059 (0.157)	0.078 (0.038)	0.194 (0.002)	0.187 (0.000)	0.479 (0.000)	0.222 (0.000)	0.168 (0.108)
Smart Balance	0.064 (0.299)	0.017 (0.756)	0.228 (0.050)	0.175 (0.058)	0.313 (0.063)	-0.015 (0.881)	0.140 (0.426)
All Other	0.092 (0.036)	0.030 (0.397)	0.098 (0.025)	0.062 (0.092)	0.410 (0.000)	0.011 (0.779)	-0.036 (0.594)

Table 8. Continued

	Parkay	*Promise*	*Shedd's*	*Private Label*	*Smart Balance*	*All Other*
Benecol	0.166	0.135	-0.143	0.279	0.215	0.392
	(0.346)	(0.089)	(0.412)	(0.157)	(0.299)	(0.036)
Take Control	0.258	0.052	-0.242	0.380	0.057	0.131
	(0.089)	(0.442)	(0.110)	(0.038)	(0.756)	(0.397)
Blue Bonnet	0.300	0.069	0.358	0.233	0.195	0.106
	(0.001)	(0.015)	(0.001)	(0.002)	(0.050)	(0.025)
Fleischmann's	0.054	0.087	0.239	0.365	0.244	0.109
	(0.687)	(0.030)	(0.122)	(0.000)	(0.058)	(0.092)
I Can't Believe Its Not Butter	0.103	0.044	0.583	0.228	0.107	0.177
	(0.130)	(0.019)	(0.000)	(0.000)	(0.063)	(0.000)
Imperial	0.193	0.114	0.616	0.376	-0.019	0.017
	(0.083)	(0.003)	(0.000)	(0.000)	(0.881)	(0.779)
Land O' Lakes	0.287	0.027	0.489	0.173	0.103	-0.033
	(0.012)	(0.517)	(0.001)	(0.108)	(0.426)	(0.594)
Parkay	-2.008	0.020	0.544	0.304	-0.111	0.212
	(0.000)	(0.642)	(0.000)	(0.006)	(0.388)	(0.003)
Promise	0.091	-2.248	0.070	0.210	0.327	0.011
	(0.642)	0.000	(0.718)	(0.283)	(0.170)	(0.937)
Shedd's	0.213	0.006	-1.577	0.153	0.123	0.083
	(0.000)	(0.718)	0.000	(0.002)	(0.047)	(0.002)
Private Label	0.286	0.045	0.369	-2.182	0.224	-0.129
	(0.006)	(0.283)	(0.002)	0.000	(0.063)	(0.073)
Smart Balance	-0.146	0.097	0.415	0.312	-1.656	0.057
	(0.388)	(0.170)	(0.257)	(0.063)	(0.000)	(0.579)
All Other	0.220	0.003	0.220	-0.143	0.045	-1.012
	(0.003)	(0.937)	(0.002)	(0.073)	(0.578)	(0.000)

Note: The figures in the parentheses are the corresponding p-values.

Indirect Price Effects

The price effects refer to the changes in the prices of existing brands due to the introduction of new products, i.e., phytosterol-enriched margarines. The new brand introduction can lead to either an increase or decrease in the prices of existing brands (Hausman and Leonard, 2002). Direct estimates of price effects are based on pre and post-introduction data. However, in many circumstances such as ours, data from the period prior to the new product introduction are not available. Thus, a method for estimating the price effects of a new product in the absence of pre-introduction data would be useful. Following the indirect method employed by Hausman and Leonard (2002), we use the estimated demand system discussed previously, along with an assumed model of competition (i.e., Nash-Bertrand) to estimate indirectly the price effects of the introduction of phytosterol-enriched products' introduction indirectly.

Suppose there are *n* firms producing m brands of margarine. Consider the firm that produces the first *k* products. Under the Nash-Bertrand assumption, it maximizes profit, taking the prices of other brands as given. The first order condition for the firm is,

$$(3.9)\qquad w_i(p_1,\ldots,p_n)+\sum_{j=1}^{k}\frac{p_j-c_j}{p_j}w_j(p_1,\ldots,p_n)e_{ji}(p_1,\ldots,p_n)=0\,\forall i=1,\ldots,k$$

where w_i denotes the expenditure shares of i^{th} brand, e_{ji} represents the demand elasticities of j^{th} brand with respect to price of i^{th} brand. Each of the firms has a set of first-order conditions similar to equation (9). The marginal costs are obtained by solving these equations simultaneously with the estimated elasticities and evaluated at the means of prices and expenditure shares. The estimated price-cost margins are presented in Table 9. The estimates are relatively similar among the brands with the exception of Land O' Lakes and All Other Brands.

Table 9. Estimated Price-Cost Margins

Brands	Estimated Marginal Cost	Average Price	Percent Change (%)
Benecol	4.94	9.43	47.64
Take Control	3.21	7.04	54.39
Blue Bonnet	0.29	0.68	56.92
Fleischmann's	0.70	1.50	53.46
I Can't Believe Its Not Butter	0.78	1.89	58.63
Imperial	0.34	0.72	52.61
Land O' Lakes	0.52	1.80	71.38
Parkay	0.61	1.22	49.84
Promise	1.09	1.95	44.17
Shedd's	0.41	0.93	55.59
Private Label	0.36	0.64	44.16
Smart Balance	0.82	2.00	59.05
All Other Brands	0.09	1.22	92.52

Given the marginal costs, we are now in a situation to calculate the virtual prices of brands in the absence of the new product. In order to do that, we force the demand of the new product to be zero and solve the first order conditions other than the new product. In this context, we study the price effects using three cases: removal of Benecol, removal of Take Control and removal of both phytosterol-enriched products. The estimated price effects are presented in Table 10.

Interestingly, the prices of all existing products increase, albeit in relatively small magnitudes, after the introduction of phytosterol products. The result perhaps is due to notably higher average prices commanded by the new phytosterol products. The separate introduction of Benecol and Take Control has similar effects on the prices of the existing brands. With the exception of “all other brands”, the price effects are generally small, ranging from 0.08% to 3.35%. The relative small changes in prices of existing brands can be attributed to the little substitutability of these brands with respect to the phytosterol-enriched products.

Table 10. Price Effects of Benecol and Take Control Introduction

	Benecol (%)	Take Control (%)	Benecol and Take Control (%)
Benecol	-	0.40	-
Take Control	0.93	-	-
Blue Bonnet	0.66	0.66	0.69
Fleischmann's	3.35	3.34	3.68
I Cant Believe Its Not Butter	0.53	0.51	1.02
Imperial	0.66	0.65	1.30
Land O' Lakes	3.15	3.06	6.13
Parkay	0.08	0.08	0.13
Promise	0.23	0.22	0.44
Shedd's	0.23	0.22	0.43
Private Label	0.08	0.08	0.14
Smart Balance	1.16	1.11	2.24
All Other Brands	26.61	26.08	51.19

The combined price effects of both Benecol and Take control are approximately the sum of their individual marginal effects except for Blue Bonnet, Fleischmann’s and Parkay. Produced by the same manufacturer, ConAgra Foods, these products are less affected when both of the phytosterol-enriched products are introduced simultaneously than separately. It might indicate that companies with more brands in marketplace are less vulnerable to the introduction of new products.

Concluding Remarks

Food companies now 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; C. L. Brown and Carpenter, 2000; Nowlis and Simonson, 1996; Simonson, Carmon, and O'Curry, 1994). 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. To fill this void, we employed weekly scanner data over the period August 11, 2003 to September 4, 2005 to focus on the case of a health-related attribute present in only two margarine products: phytosterol. Using the Barten synthetic demand system that subsumes the commonly used functional forms such as the LA/AIDS, the Rotterdam model, the CBS model and the NBR model, 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 degree of substitutability among the products.

Our findings generally suggest that the market views the phytosterol-enriched products differently from the products without the phytosterol attribute. Our results indicate that the phytosterol-enriched margarine products, Benecol and Take

Control, command noticeably high premiums relative to other margarine brands. A striking result is that despite these large premiums, consumer demand is not as sensitive to price changes as other products within the margarine category (i.e., Blue Bonnet, Promise, Private Label). In other words, the estimated own-price elasticities for Benecol and Take Control, even though in the elastic range as with the case of other brands, are not among the highest in the category. Another indication that consumers are viewing these two phytosterol-enriched products differently from the other products is evidence of strong substitutability between them as suggested by the cross-price elasticities. However, substitutability among phytosterol and non-phytosterol brands is not evident. It is then plausible to assume that consumers purchase these brands most likely on account of the health-related phytosterol attribute. These results imply that adding a functional or healthy attribute to a food product indeed can be a good way of differentiating one's product in the marketplace.

This study provides insights into how the use of scanner data and demand systems analysis can be used to assess the demand of existing functional foods vis-à-vis other competing products. Future studies should replicate our analysis for other product categories to assess the robustness of our findings. Moreover, although beyond the scope of our analysis, our study does not focus on and directly analyze the welfare effects of the introduction of a functional food product into a market. This type of analysis, however, would require data from both before and after the introduction of the new functional food product to directly estimate the effect of new product introduction on the prices of existing products within the product category. With data availability, future studies also should include other variables such as demographics and advertising in the analysis. The presence of demographic variables in the models can provide insights into the segments that food marketers can target for specific functional foods. More direct evaluation of the value of health-related attributes also can be conducted using experimental economics methodologies (e.g., experimental auctions, choice experiments) by eliciting consumers' willingness to pay for novel products with functional properties that are not yet in the market.

CHAPTER IV

ON THE USE OF PRICE ELASTICITY ESTIMATES FROM A FLEXIBLE DEMAND SYSTEM TO ASSESS CANNIBALIZATION EFFECTS: AN EMPIRICAL ANALYSIS

New product introduction has always been a popular strategy for firms seeking growth (Reddy, Holak and Bhat 1994). According to Marketing Intelligence Services Productscan Online, new product introductions continue to climb, reaching 33,285 in 2004. Many of these new introductions are in the U.S. food sector, which is going through rapid transformations (Dhar and Foltz 2005). For example, new food products with health attributes have become increasingly popular because they are widely believed to offer consumers an increased ability to reduce the risk of certain diseases or health problems (Schmidt, 1999). One example of a functional food is the incorporation of plant sterols into orange juice.

Introducing successful new brands are more difficult due to rising advertising costs and increasing competition in distribution channels and customer outlets. It is also observed that consumers generally are committed to brands they trust (Holleran 2005; Mason and Milne 1994). Thus, firms increasingly have used line extensions to improve firm performance. Line extensions refer to the use of an established brand for a new offering in the same product class or category, and they differ from their parent brand in relatively minor ways. Reddy et al. (1994) argued that line extensions attempt to capitalize on the awareness of the parent brand and the associations linked to it. Therefore, line extensions tend to be more successful for strong brands.

Though the introduction of line brand extensions has become prevalent, it does not necessarily guarantee a success. Reddy et al. (1994) worried that an extension may cannibalize sales of existing products and dilute the image of the original brand over time. There are also other issues associated with line extensions. For example, Tauber (1981) argued that an unsuccessful product might likely affect the parent brand adversely; Ries and Trout (1986) contended that extensions might dilute a brand's image in consumers' mind.

One of the critical issues for firms that offer multiple products is cannibalization. Cannibalization has been defined in several ways. For example, Heskett (1976) defined it as "the process by which a new product gains sales by diverting them from an existing product", while Copulsky (1976) 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 related cannibalization to new product introduction and did not restrict it to products that are offered by the same firm. In this paper, we employ Copulsky's definition of cannibalization because it refers to the competition between products offered by the same firm. Heskett's definition is more concerned with the process of cannibalization rather than its magnitude (Lomax et al, 1997).

The effect of cannibalization on brand performance has been the subject of debate. Lomax et al. (1997) argued that cannibalization is a real threat for the vast majority of new product launches. Child et al. (1991) noted that cannibalization must be tolerated because of substitution threats from competitors. Both of these studies argue that it is better for the firm to experience cannibalization than to let competitors draw market share from the company's potentially vulnerable brand(s).

Theoretically, a firm prefers to differentiate its products and price schedules so that each consumer can find an offer that matches his or her preferences – a case that corresponds to perfect price discrimination. Generally, a wide product line could help a firm preempt an entire market, protect entrenched niches, or develop brand reputation (Hui 2004). Further, product line extension allows a firm to strengthen brand reputation and extend it to new products.

However, extensive differentiation is not feasible due to the difficulty in identifying consumer preferences and due to possible increases in production and operating costs. More importantly, it may lead to undesirable competition among the products and limit the collective sales of the entire product line for the same firm. The underlying rationale is that consumers view products that share the same brand as rather similar, and they tend to evaluate the products jointly (Hui 2004).

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). Cannibalization studies are important to multi-product 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). No standard measures of cannibalization have been proposed in the literature, however. Moorthy and Png (1992) used a modeling approach to demonstrate that cannibalization affects the optimal timing of new product introductions, but they do not provide measures to quantify its effects. Mason and Milne (1994) proposed an approach for identifying cannibalization in mature cigarette markets. Van Herdee et al. (2003) developed a technique to decompose sales into a series of regression models based on relevant criteria in order to study the effects of promotion on products. They considered a product to be cannibalized if there is a loss in net sales because of promotion of a product within the same brand. More recently, Srinivasan et al. (2005a) proposed to use volume and market share changes with a new product introduction to investigate the effects of cannibalization focusing on the beverage industry. Srinivasan et al. (2005b) developed a quantitative method integrated with existing Autoregressive Integrated Moving Average (ARIMA) models to measure cannibalization. They concluded that the combined model provides better forecasting results; however, it needs subjective judgment on identifying “victim(s)” of new product introduction before incorporated in the ARIMA model. Specifically, Lomax et al. (1997) examined three measures of cannibalization, namely, gain-loss analysis, duplication of purchase tables and deviations from expected share movements. They empirically focused on detergent markets in United Kingdom and Germany using household data. For the purpose of comparison, we apply two methods of Lomax et al. (1997), namely, gains-loss analysis and deviations-from-expected-market-share-movement analysis.

Our objective is to show that: (1) the use of cross-price elasticities from demand system models can complement the use of Lomax et al.'s (1997) measures and that (2) the use of these elasticities provides a more definitive measure of cannibalization effects. We use the introduction of Minute Maid Heart Wise orange juice as a case study. The phytosterol-enriched product was introduced in late October 2003. Phytosterol is proved to effectively lower blood cholesterol levels by inhibiting cholesterol absorption by clinical studies. The first phytosterol-enriched product, Benecol margarine was launched in Finland in 1995. The phytosterol-enriched products currently in the market include Benecol and Take Control margarines, Minute Maid Heart Wise orange juice, Natural Valley granola bar, Kellogg's Smart Start breakfast cereal, and Sara Lee Heart Healthy bread.

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 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 only concerns ready-to-drink orange juice. The orange juice category contains 628 Universal Product Codes (UPC) over the study period.

UPCs are aggregated with reference to brands in order to limit the number of products to consider. The various brands examined are: (1) Minute Maid; (2) Tropicana; (3) Florida's Natural; (4) Private Label Orange Juice; and (5) all other branded orange juice. Prices of these branded products then are calculated by dividing the sales by the corresponding volume. Since we do not have data on sales promotions, we do not have information on whether there are any promotions going on during a certain week.

The principal product of interest is Minute Maid Heart Wise, 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 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 98 weeks from October 2003 to September 2005.

In Table 11, we present the descriptive statistics of ready-to-drink orange juice prices. As expected, Private Label orange juice has the lowest price on average. Tropicana is the most expensive orange juice product. Interestingly, the Minute Maid Heart Wise product is priced lower than other Minute Maid products on average.

Descriptive statistics for average juice sales and volume are presented in Tables 12 and 13. 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 sales and volume are the lowest among the various brands. In terms of market shares (Table 14), Tropicana commands the highest market share, followed by Minute Maid. The average market share for Minute Maid Heart Wise over the study period is 0.86 percent. After January 2004, market shares of the Minute Maid Heart Wise product stabilized at approximately 0.96 percent.

Table 11. Descriptive Statistics of Orange Juice Prices ($/half gallon), October 2003 to September 2005

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

Table 12. Descriptive Statistics of Orange Juice Sales ($), October 2003 to September 2005

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

Table 13. Descriptive Statistics of Orange Juice Quantity (Volume in half gallons), October 2003 to September 2005

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	3,464,548
Tropicana	8,547,591	1,243,872	6,620,358	8,264,600	12,971,113
Private Label	5,123,841	472,529	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

Table 14. Descriptive Statistics of Orange Juice Market Shares (%) by Brand, October 2003 to September 2005

Brand	Mean	Std Dev	Min	Median	Max
Minute Maid Heart Wise	0.86	0.29	0.00	0.92	1.29
Other Minute Maid	16.32	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

Methodology

To assess cannibalization effects, we compare the use of two conventional measures developed by Lomax et al. (1997), gains-loss analysis and deviations-from-expected-market-share-movement analysis with cross-price elasticity estimates from a flexible demand system. The two conventional measures use differences in the market shares before and after introduction of new entrants to measure cannibalization effects. Specifically, with gain-loss analysis, we calculate the difference in market shares before and after the new product introduction and measure the proportion of loss or gain to the new entrant. For example, if the brand produced by the same manufacturer, Other Minute Maid in our case, has a "significant" loss to the new entrant, Minute Maid Heart Wise, there exists cannibalization.

On the other hand, with the deviations-from-expected-market-share-movements measure, we assume that the magnitude of expected cannibalization would be proportional to the share held by existing brands prior to the new product launch (Lomax et al. 1997). This measure is calculated as the difference between the actual share and the expected share in the post-introduction period, assuming no change in the overall structure of the market. The expected shares are calculated by multiplying the pre-introduction shares by the total market shares held by all existing brands in the post-introduction period. Cannibalization is considered present if the difference between actual market share and expected market share is statistically significant in the post-introduction period.

A major problem with these conventional measures is simply that they ignore other relevant factors that may explain market share movements. That is, neither the gain-loss analysis nor the deviations-from-expected-market-share-movements analysis controls for other determinants that could affect changes in product market shares.

To overcome this issue, we argue that the use of cross-price elasticities derived from demand system models complements the use of market share measures to examine cannibalization effects. In contrast to analysis based on market shares, the use of demand systems is appealing because of their design to deal with interdependencies of all products, in our case different orange juice brands. Through the use of demand systems, we control for prices and expenditures of all products. A demand system model also recognizes that increases in consumption of some products must be balanced by decreases in consumption of others.

By definition, the cross-price elasticity of good A with respect to good B is the percentage change in the quantity of good A due to a one percent change in the price of good B. The cross-price elasticity concept centers attention on the sensitivity of consumption of good A to changes in the price of good B. If the cross-price elasticity is positive, then goods A and B are substitutes. If the cross-price elasticity is negative, then goods A and B are complements. If the cross-price elasticity is zero, then goods A and B are independent.

Recall that cannibalization occurs only when consumers purchase one product at the expense of other products offered by the same firm. So, let goods A and B pertain to products offered by the same firm; then under the condition that total expenditure of the product category does not change, the existence of cannibalization is tantamount to positive (compensated) cross-price elasticities of demand.

Identification of Cannibalization Effects Based on Conventional Analysis

In Table 15, we present the empirical results of the gain-loss analysis. The Minute Maid brands fell from 17.03 percent (pre-introduction of Minute Maid Heart Wise) to 16.32 percent (post-introduction of Minute Maid Heart Wise). This decline in market share was statistically significant at the 0.05 level. Market shares of Tropicana brands and Private Label brands also decreased significantly after the introduction of Minute Maid Heart Wise. But, market shares of Florida's Natural and All Other Brands as a composite group rose significantly after the introduction of the phytosterol product.

As exhibited in Table 16, similar to the results gleaned from the gains-loss analysis, it is evident that there are statistically significant differences in market shares with the introduction of Minute Maid Heart Wise. Differences between expected and actual shares with the introduction of Minute Maid Heart Wise were negative for other

Minute Maid brands, Tropicana brands, and Private Label brands. But these differences were positive for Florida's Natural and All Other Brands of orange juice.

Table 15. Launch of Minute Maid Heart Wise Orange Juice Analyzed by Gain-Loss Analysis

Brands	Pre-introduction (%)	Post- introduction (%)	Difference (%)
Other Minute Maid	17.03	16.32	-0.70 (0.049)
Florida's Natural	8.59	9.51	0.92 (0.047)
Private Label	16.53	15.75	-0.78 (0.003)
Tropicana	45.50	43.87	-1.63 (0.063)
All other brands	12.35	13.69	1.34 (0.000)

Note: the figures in parentheses are associated p-values.

Table 16. Launch of Minute Maid Heart Wise Orange Juice Analyzed by Deviations-from-Expected-Market-Share-Movements Measure

Brand	Actual share of purchase Pre-launch (%)	Predicted share of purchase Post-launch (%)	Actual share of purchase post-launch (%)	Difference (%)
Other Minute Maid	17.03	16.88	16.32	-0.56 (0.00)
Florida's Natural	8.59	8.51	9.51	0.99 (0.00)
Tropicana	45.50	45.11	43.87	-1.24 (0.00)
Private Label	16.53	16.39	15.75	-0.64 (0.00)
All Other Brands	12.35	12.24	13.69	1.45 (0.00)

Notes: 1. The figures in parentheses are associated p-values.
2. The predicted share of purchase in the post-launch period is calculated by multiplying the corresponding share in the pre-launch period by the sum of column of actual shares. For example, for other Minute Maid, 16.88 = 17.03 x (16.32 + 9.51 + 43.87 + 15.75 + 13.69)

Bottom line, based on the conventional analysis of market shares developed by Lomax et al., cannibalization effects between Minute Maid Heart Wise and other

Minute Maid brands were evident. But, these measures do not control for other factors that could lead to decreases or increases in product market shares. Also, these measures can only be applied to examine cannibalization effects when both pre- and post-introduction data are available.

Demand Systems

We employ a demand-system approach to derive the own-price, cross-price and expenditure elasticities of orange juice products. Emphasis is placed on the use of cross-price elasticities of demand considering cannibalization effects. Barten (1993) shows that 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), have desirable attributes. Maynard and Veeramani (2003) showed that synthetic models help avoid specification bias by allowing more generalized functional forms.

The Barten model is specified as follows:

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

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 i^{th} product, respectively and p_j denotes price of j^{th} product. $b_i, c_{ij}, \delta,$ and γ are the parameters to be estimated in the demand system.

Theoretical demand restrictions are homogeneity, symmetry and adding-up, which are given by

(4.2a) $\sum_j c_{ij} = 0 \; \forall$ i (homogeneity)

(4.2b) $c_{ij} = c_{ji} \forall \; i$ and j (symmetry)

(4.2c) $\sum_j c_{ij} = 0 \; \forall \; j$ (adding-up)

(4.2d) $\sum_i b_i = 1 - \delta$ (adding-up)

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" is chosen to be the omitted category from the system, and it is later recovered by theoretical assumptions. The theoretical restrictions of homogeneity, symmetry and adding-up 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. We also allow for the presence of an AR (1) serial correlation process in the disturbance terms in each of the demand systems.

The majority of the estimated coefficients in the demand system are statistically different from zero. 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. Importantly, based on the estimates, the Barten model is statistically superior to the Rotterdam model, the LA/AIDS model, the CBS model, and the NBR model. In the next section, we present the uncompensated and compensated elasticity estimates.

Empirical Results of the Barten Synthetic Demand Model

The estimated coefficients, standard errors, t-statistics, and goodness-of-fit statistics associated with the estimation of the Barten demand models are presented in Table 17.

Elasticity Estimates

The uncompensated and compensated price elasticities together with expenditure elasticities are presented in Tables 18 to 19. The price elasticities relate 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 money income constant. The equation for the uncompensated elasticity of brand *i* with respect to the price of brand *j* is

(4.3) $$\eta_{ij} = \frac{\left[c_{ij} - \gamma w_i\left(\delta_{ij} - w_j\right)\right]}{w_i} - w_j n_i$$

Table 17. 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	1.2895	0.7966
Other Minute Maid Equation	2.4015	0.9052
Florida's Natural Equation	2.5306	0.8622
Tropicana Equation	2.4365	0.9663
Private Label Equation	2.7202	0.6848

	Coefficient	St. Error	p-value
b_1	0.0002	0.0036	0.9505
$c_{1,1}$	0.0059	0.0033	0.0747
$c_{1,2}$	-0.0050	0.0029	0.0843
$c_{1,3}$	0.0008	0.0014	0.5503
$c_{1,4}$	0.0008	0.0019	0.6629
$c_{1,5}$	-0.0018	0.0023	0.4406
Delta	0.9492	0.3962	0.0166
Gamma	2.6604	0.3645	0.0000
b_2	-0.0252	0.0664	0.7040
$c_{2,2}$	0.0396	0.0522	0.4478
$c_{2,3}$	0.0161	0.0119	0.1757
$c_{2,4}$	-0.0212	0.0289	0.4638
$c_{2,5}$	-0.0150	0.0145	0.2988
b_3	0.0239	0.0442	0.5890
$c_{3,3}$	-0.0850	0.0378	0.0244
$c_{3,4}$	0.0474	0.0213	0.0261
$c_{3,5}$	0.0025	0.0131	0.8466
b_4	0.1012	0.1814	0.5771
$c_{4,4}$	0.0497	0.0940	0.5969
$c_{4,5}$	-0.0656	0.0291	0.0239
b_5	-0.0296	0.0638	0.6427
$c_{5,5}$	0.1324	0.0539	0.0140
ρ	-0.3731	0.0492	0.0000

Notes: 1. SHAZAM 9.0 is used to estimate the Barten (1993) model.
2. ρ refers to the autocorrelation coefficient.
3. The estimated coefficients b_i's and $c_{i,j}$'s are corresponding to equation 1. Subscript 1 represents Minute Maid Heart Wise, 2 refers to Other Minute Maid, 3 represents Florida's Natural, 4 denotes Tropicana, and 5 denotes Private Label. For example, c_{12} refers to the effects of Other Minute Maid on the demand of Minute Maid Heart Wise.

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

(4.4) $$\eta_{ij}^{*} = \frac{\left[c_{ij} - \gamma w_i\left(\delta_{ij} - w_j\right)\right]}{w_i}$$

The difference between the two types of cross-price elasticities depends on the size of the income elasticity of the product and the importance of the product whose price has changed, measured by the share of consumer's budget spent on the product whose price has changed. Both types of elasticities are reported in Tables 18 and 19.

We also calculated the expenditure elasticities and these are computed as:

(4.5) $$\eta_i = \frac{\left(b_i + \delta w_i\right)}{w_i}$$

The respective elasticities are functions of estimated parameters and expenditure shares. We calculate the elasticities using sample means of the expenditure shares. As shown in Table 18, the uncompensated own-price elasticities range from -1.52 (Private Label) to –3.41 (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 -1.96, slightly lower than the own-price elasticities of other Minute Maid brands (-2.11).

Table 18. Uncompensated Own-Price and Cross-Price Elasticities and Expenditure Elasticities Associated with the Brands

	Minute Maid Heart Wise	Other Minute Maid	Florida's Natural	Tropi-cana	Private Label	All Other Brands	Expen-diture
Minute Maid Heart Wise	-1.96 (0.00)	-0.31 (0.37)	0.26 (0.12)	0.83 (0.00)	0.06 (0.81)	0.15 (0.51)	0.97 (0.00)
Other Minute Maid	-0.01 (0.42)	-2.11 (0.00)	0.28 (0.00)	0.69 (0.00)	0.20 (0.01)	0.17 (0.02)	0.79 (0.00)
Florida's Natural	0.02 (0.15)	0.41 (0.00)	-3.42 (0.00)	1.14 (0.00)	0.26 (0.05)	0.39 (0.00)	1.20 (0.00)
Tropicana	0.01 (0.00)	0.19 (0.00)	0.25 (0.00)	-1.90 (0.00)	0.08 (0.02)	0.18 (0.00)	1.18 (0.00)
Private Label	0.01 (0.71)	0.21 (0.01)	0.20 (0.01)	0.42 (0.00)	-1.52 (0.00)	-0.07 (0.41)	0.76 (0.00)
All Other Brands	0.01 (0.45)	0.20 (0.02)	0.31 (0.00)	0.73 (0.00)	-0.09 (0.38)	-1.96 (0.00)	0.81 (0.00)

Note: the figures in parentheses are the corresponding p-values.

Expenditure elasticities, which relate the percentage change in volume sold due to a one percent change in total expenditure on the orange juice category, vary from 0.76 (Private Label) to 1.20 (Florida's Natural). When total expenditure on 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 19, the dominance of positive compensated cross-price elasticities indicates that the products in question are substitutes. 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.

Table 19. Compensated Own-Price and Cross-Price Elasticities Associated with the Brands

	Minute Maid Heart Wise	Other Minute Maid	Florida's Natural	Tropicana	Private Label	All Other Brands
Minute Maid Heart Wise	-1.96 (0.00)	-0.15 (0.66)	0.35 (0.03)	1.26 (0.00)	0.22 (0.39)	0.28 (0.21)
Other Minute Maid	-0.01 (0.66)	-1.98 (0.00)	0.35 (0.00)	1.04 (0.00)	0.33 (0.00)	0.28 (0.00)
Florida's Natural	0.03 (0.03)	0.60 (0.00)	-3.30 (0.00)	1.67 (0.00)	0.45 (0.00)	0.56 (0.00)
Tropicana	0.02 (0.00)	0.39 (0.00)	0.36 (0.00)	-1.38 (0.00)	0.27 (0.00)	0.34 (0.00)
Private Label	0.01 (0.39)	0.34 (0.00)	0.27 (0.00)	0.75 (0.00)	-1.40 (0.00)	0.03 (0.72)
All Other Brands	0.02 (0.21)	0.33 (0.00)	0.39 (0.00)	1.09 (0.00)	0.04 (0.72)	-1.85 (0.00)

Note: the figures in parentheses are the corresponding p-values.

The competition between national brands is stronger than the competition between national brands and private label items. Sethuraman and Srinivasan (2002) show that asymmetric competitive effects identified from elasticities between high-share brands and low-share brands may merely be due to their market share difference. However, the results in our study is not soly attributed to the market share effects, because the share of the private label is comparable to the share of Other Minute Maid and is greater than that of Florida's Natural.

Identification of Cannibalization Effects through the Use of Cross-Price Elasticities of Demand

Based on the estimated cross-price elasticities, both uncompensated and compensated, the price changes in Minute Maid Heart Wise orange juice do not statistically affect the demand for other Minute Maid orange juice products and vice versa. In other words, the product of interest, Minute Maid Heart Wise, is not considered a substitute for the other Minute Maid orange juice products, and hence cannot cannibalize the sales of these other products. These orange juice products technically are independent. Therefore, contrary to the results from two conventional measures of cannibalization (gains loss analysis and deviation from expected market share movements analysis), our results based on estimated cross-price elasticities suggest no cannibalization effects from the introduction of phytosterol-enriched Minute Maid orange juice (i.e., Minute Maid Heart Wise). 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).

Concluding Remarks

Although the issue of cannibalization has been well documented in the literature, most previous research makes use of market shares to measure the magnitude of cannibalization. Using a flexible demand system model and scanner data, we showed that the use of cross-price elasticities might provide a more definitive picture of cannibalization effects.

Using the case of an introduction of a functional food in the category of orange juice, we showed that conventional market share measures, both gain-loss analysis and deviations-from-expected-market-share-movements analysis, indicate the existence of cannibalization effects between Minute Maid Heart Wise and other Minute Maid orange juice. However, these two measures could not fully explain the market share changes before and after the introduction of new product. On the other hand, no cannibalization effects can be identified by the cross-price elasticities between Minute Maid Heart Wise and other Minute Maid orange juice; that is, these two products are independent. We pointed out that the conventional market share based measures may not provide a complete picture of cannibalization effects since they do not control for possible effects of other factors (e.g., price interactions between brands within the same product category). Given the condition that the total expenditure of the product category does not change, cross-price elasticities can be a reliable measure of cannibalization effects.

Our study provides a framework to study cannibalization effects using cross-price elasticities from a flexible demand system. While flexible demand system estimation has garnered some popularity in the economics literature, its use has been more limited in the marketing literature. 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. They also can assess the profit implications of different strategies in the light of cannibalization within a line to help them develop marketing strategies needed to launch new products.

As a caveat, our study deals only with a specific cannibalization concept related to competition between products offered by the same firm. With data availability, future studies also can incorporate demographics and advertising expenditures in the analysis. With micro-level data, a researcher will be able to distinguish the new customers and the customers that switch to other brands, thus providing information on market expansion effects. It also may provide some insights for market segmentation strategies. Future research should also replicate our study with other product categories to assess the robustness of our findings. Given our findings, it may suggest that products with health-attribute may not be in the same market as the "regular" products. With micro-level data, it makes possible to study the market expansion effects. Thus, it may provide an incentive for companies to introduce more new products into the category by adding varying health attributes. In addition, it would be interesting to know which products or product categories would lead to cannibalization.

CHAPTER V

CONSUMER WELFARE EFFECTS ASSOCIATED WITH INTRODUCTION OF A NEW FUNCTIONAL FOOD PRODUCT

As markets become more consumer-oriented and demand-driven, many firms are continuously developing and introducing new products. One such growth area due to rising interest in health and nutrition issues is the functional foods market. Defined as foods or food components that may provide a health benefit beyond basic nutrition, functional foods are widely 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) shows that consumer demand for functional foods has steadily increased since 1996. Hasler (1998) also rated functional foods highly, second only to low-fat foods as a key product development opportunity.

With the increasing popularity of functional foods, one issue that needs to be examined is the competitive or consumer welfare effects associated with their introduction into the market. An important economic question is how much consumers benefit from new functional food introductions. Consumer welfare, used in this article to also mean competitive effects in an anti-trust parlance, is affected by new product introductions because it increases product variety. For example, consumers gain surplus associated with the new variety especially if the new product is not very similar to existing products. The magnitude of this surplus is a function of how close the new product is to existing products in the minds of consumers. In addition, new product introduction influences consumer welfare by increasing competition for existing products. The magnitude of the welfare effects depends again on the substitutability of the new and existing products. The overall net effect on consumers of a new product introduction is the sum of the variety effect and the price effect (Hausman 1997).

In January 2005, Yoplait introduced Healthy Heart yogurt, the first yogurt containing cholesterol-lowering plant sterols to be sold in the United States. Our objective in this article is to examine the welfare effects of the introduction of Yoplait Healthy Heart product in the yogurt category, following the approach taken by Hausman and Leonard (2002). To explore the source of consumer welfare change, we decompose the consumer surplus into a variety effect and a price effect. The price effect measures the welfare change from the market with the existing brands to the market with the new product added. In measuring the price effects, we use the direct and indirect methods. With the direct method, we do not have to assume the market structure. However, we need to analyze both pre- and post-introduction data. On the other hand, with the indirect method, we have to assume a market structure but we only need the post-introduction data. We then compare the results of these two methods.

Using retail scanner data and a demand system based on Gorman's two-stage budgeting concept, we sequentially estimate the yogurt demand at the brand level and at the top level. With the estimated demand elasticities, we obtain the marginal cost from the equilibrium conditions, which we then use to estimate the price effects of the new products. The variety effects are subsequently calculated with the two-level demand system while setting the expenditure share of the new product to zero. Finally, we calculate the consumer welfare based on the estimates of price effects and variety effects. Our findings suggest significant consumer welfare effects comprising of a small price effect and a notable variety effect.

The rest of the paper is organized as follows. In Section II, we examine the data and its descriptive statistics. We then explain the estimation of demand and pricing relationships in Section III. We present the calculations of compensating variation (CV) in Section IV and conclude in Section V.

Data and Descriptive Statistics

Our data consist of weekly sales and volume information on yogurt products obtained from Information Resources, Inc. (IRI). The yogurt category covers 1841 Universe Product Codes (UPC) from August 11, 2003 to September 4, 2005 for a total of 108 weekly observations. However, the new product that contains phytosterol, Yoplait Healthy Heart, was introduced in the marketplace in January 2005. Therefore, the statistical analysis after the product introduction covers the period January 2005 to September 2005, comprising a total of 36 weekly observations. UPCs are aggregated into 12 different brands, namely, (1) Yoplait Healthy Heart, (2) other Yoplait, (3) Breyer's, (4) Colombo, (5) Dannon, (6) LA yogurt, (7) Mountain High, (8) Stonyfield Farm, (9) Private Label, (10) Wells Blue Bunny, (11) Yofarm and (12) all other branded yogurt products.

As exhibited in Table 20, the phytosterol-containing yogurt product, Yoplait Healthy Heart, is less expensive than other Yoplait yogurt products on average.

Stonyfield Farm has the highest price at $1.88 per pint and Private Label the lowest price at $1.02 per pint. In terms of average sales, other Yoplait ranks the highest at close to $20 million per week followed by Dannon at roughly $12 million per week. Other Yoplait and Dannon also are the category leaders in terms of number of pints sold per week (Table 20). Together, these brands combine for roughly 65 percent of the market. Also noteworthy is the virtual stability of the market shares of yogurt over the time period from January 2005 to September 2005.

Table 20. Descriptive Statistics of Yogurt Prices, Dollar Sales, Volume Sales and Market Shares, January 2005 to September 2005

Brand	Price ($/pint)	Sales ($)	Volume (pints)	Market Shares (%)
Yoplait Healthy Heart	1.69	354,727	210,692	0.69
Other Yoplait	1.74	18,931,263	10,899,150	37.06
Breyer's	1.19	1,914,254	1,607,546	3.74
Colombo	1.43	886,593	624,809	1.74
Dannon	1.65	12,423,854	7,560,484	24.34
LA Yogurt	1.25	751,944	610,731	1.48
Mountain High	1.29	663,752	514,839	1.30
Stonyfield Farm	1.88	3,011,454	1,603,526	5.91
Private Label	1.02	7,184,570	7,055,341	14.09
Wells Blue Bunny	1.47	704,010	479,978	1.38
Yofarm	1.82	956,464	527,170	1.87
All Other Brands	1.42	3,263,971	2,247,440	6.40

Demand Estimation

Brand-level Demand Estimation

To derive the own-price, cross-price and expenditure elasticities, we employ a demand system approach. Barten (1993) shows that 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), may have desirable attributes. Maynard and Veeramani (2003) showed that synthetic models help avoid specification bias by allowing more generalized functional forms.

The Barten model is specified as follows:

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

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 denotes expenditure share of i^{th} product and p_j denotes price of j^{th} product. 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

(5.2a) $\sum_j c_{ij} = 0 \ \forall \ i$ (homogeneity);

(5.2b) $c_{ij} = c_{ji} \ \forall \ i$ and j (symmetry);

(5.2c) $\sum_j c_{ij} = 0 \ \forall \ j$ (adding-up);

(5.2d) $\sum_i b_i = 1 - \delta$ (adding-up).

Multicollinearity, degrees of freedom issues, and computational limitations necessitate aggregation across UPCs (Capps and Love, 2002). Hence, as previously mentioned, we aggregated the UPCs into 12 products.

In estimating the Barten (1993) demand system, one equation is dropped (i.e., all other brands) to avoid estimation problems due to the singularity of the variance-covariance matrix of disturbance terms. The theoretical restrictions of homogeneity, symmetry and adding-up are imposed. An Iterated Seemingly Unrelated Regression (ITSUR) technique is applied taking into account the contemporaneous correlation of the disturbance terms among the equations. We also allow for the presence of an AR (1) serial correlation process in the disturbance terms.

The estimated coefficients, standard errors, p-values, and goodness-of-fit statistics associated with the estimation of the Barten demand model are exhibited in Table 21. The majority of the estimated coefficients in the demand system are statistically different from zero. The goodness-of-fit statistics indicate that the individual equations of the demand system explain a notable amount of the variability in the dependent variable. Importantly, the generalized Barten model statistically is superior to the Rotterdam model, the LA/AIDS model, the CBS model, and the NBR model.

Table 21. Parameter Estimates, Standard Errors, p-values and Goodness of Fit Statistics for the Synthetic Barten

	Durbin-Watson	R-Squared
Yoplait Healthy Heart Equation	1.461	0.604
Other Yoplait Equation	2.712	0.961
Breyer's Equation	2.739	0.881
Colombo Equation	2.882	0.837
Dannon Equation	2.624	0.936
LA Equation	2.804	0.913
Mountain High Equation	2.544	0.773
Stonyfield Farm Equation	2.906	0.867
Private Label Equation	2.443	0.859
Wells Blue Bunny Equation	2.688	0.896
Yofarm Equation	2.602	0.936

Coefficient	Estimates	Standard Error	p-value
b_1	0.001	0.007	0.937
$c_{1,1}$	0.007	0.005	0.180
$c_{1,2}$	-0.009	0.011	0.382
$c_{1,3}$	0.001	0.004	0.695
$c_{1,4}$	-0.003	0.003	0.360
$c_{1,5}$	0.009	0.005	0.108
$c_{1,6}$	0.001	0.002	0.741
$c_{1,7}$	-0.004	0.002	0.045
$c_{1,8}$	0.003	0.004	0.483
$c_{1,9}$	-0.003	0.002	0.163
$c_{1,10}$	-0.004	0.007	0.615
$c_{1,11}$	-0.004	0.002	0.064
Delta	1.484	0.648	0.022
Gamma	3.760	0.451	0.000
b_2	-0.108	0.236	0.646
$c_{2,2}$	0.339	0.115	0.003
$c_{2,3}$	-0.013	0.014	0.361
$c_{2,4}$	-0.009	0.010	0.351
$c_{2,5}$	-0.162	0.048	0.001
$c_{2,6}$	-0.012	0.008	0.135
$c_{2,7}$	0.000	0.006	0.952
$c_{2,8}$	-0.044	0.015	0.004
$c_{2,9}$	0.004	0.007	0.511
$c_{2,10}$	-0.031	0.030	0.288
$c_{2,11}$	0.007	0.007	0.291
b_3	-0.005	0.028	0.867
$c_{3,3}$	0.044	0.019	0.022

Table 21. Continued

Coefficient	Estimates	Standard Error	p-value
$c_{3,4}$	-0.001	0.004	0.814
$c_{3,5}$	-0.023	0.010	0.028
$c_{3,6}$	0.001	0.003	0.830
$c_{3,7}$	-0.001	0.003	0.600
$c_{3,8}$	-0.004	0.005	0.460
$c_{3,9}$	0.005	0.003	0.079
$c_{3,10}$	-0.008	0.009	0.400
$c_{3,11}$	0.001	0.003	0.714
b_4	-0.007	0.013	0.603
$c_{4,4}$	0.019	0.010	0.045
$c_{4,5}$	0.006	0.007	0.369
$c_{4,6}$	0.002	0.002	0.449
$c_{4,7}$	-0.002	0.002	0.171
$c_{4,8}$	0.004	0.004	0.372
$c_{4,9}$	-0.001	0.002	0.533
$c_{4,10}$	-0.021	0.007	0.002
$c_{4,11}$	-0.003	0.002	0.147
b_5	-0.137	0.162	0.396
$c_{5,5}$	0.296	0.087	0.001
$c_{5,6}$	-0.006	0.006	0.310
$c_{5,7}$	-0.007	0.003	0.014
$c_{5,8}$	-0.023	0.009	0.016
$c_{5,9}$	-0.011	0.004	0.015
$c_{5,10}$	-0.053	0.020	0.007
$c_{5,11}$	-0.004	0.004	0.330
b_6	-0.017	0.012	0.156
$c_{6,6}$	0.006	0.008	0.423
$c_{6,7}$	0.001	0.001	0.489
$c_{6,8}$	0.002	0.003	0.480
$c_{6,9}$	-0.002	0.002	0.310
$c_{6,10}$	0.012	0.005	0.019
$c_{6,11}$	-0.002	0.002	0.296
b_7	-0.018	0.009	0.050
$c_{7,7}$	0.024	0.007	0.001
$c_{7,8}$	-0.005	0.004	0.189
$c_{7,9}$	0.001	0.002	0.445
$c_{7,10}$	0.000	0.004	0.948
$c_{7,11}$	-0.001	0.002	0.600
b_8	-0.037	0.038	0.332
$c_{8,8}$	0.101	0.026	0.000

Table 21. Continued

Coefficient	Estimates	Standard Error	p-value
$c_{8,9}$	-0.006	0.003	0.067
$c_{8,10}$	-0.020	0.009	0.023
$c_{8,11}$	-0.010	0.003	0.001
b_9	-0.002	0.010	0.820
$c_{9,9}$	0.021	0.007	0.002
$c_{9,10}$	-0.008	0.005	0.116
$c_{9,11}$	0.001	0.002	0.460
$B_{,0}$	-0.102	0.093	0.271
$c_{10,10}$	0.168	0.057	0.003
$c_{10,11}$	-0.014	0.005	0.009
b_{11}	0.006	0.013	0.666
$c_{11,11}$	0.029	0.009	0.001
ρ	0.121	0.085	0.156

Notes: 1. SHAZAM 9.0 is used to estimate the Barten (1993) model.

2. The estimated coefficients b_i's and $c_{i,j}$'s are corresponding to equation 1. Subscript 1 represents Yoplait Healthy Heart, 2 refers to Other Yoplait, 3 represents Breyer's, 4 denotes Colombo, 5 denotes Dannon, 6 refers to LA, 7 represents Mountain High, 8 denotes Stonyfield Farm, 9 represents Private Label, 10 refers to Wells Blue Bunny, 11 refers to Yofarm and 12 is all other branded products . For example, c_{12} refers to the effects of Other Minute Maid on the demand of Minute Maid Heart Wise.

3. ρ refers to the autocorrelation coefficient.

Elasticity Estimates

The estimates of the uncompensated and compensated price elasticities are reported in Tables 22 to 23. The equation for the uncompensated elasticity of brand *i* with respect to the price of brand *j* is

(5.3) $$\eta_{ij} = \left[c_{ij} - \gamma w_i\left(\delta_{ij} - w_j\right)\right] / w_i - w_j n_i$$

The compensated elasticity for the *i*th product with respect to *j*th product price change is computed as:

(5.4) $$\eta^*_{ij} = \left[c_{ij} - \gamma w_i\left(\delta_{ij} - w_j\right)\right] / w_i$$

The expenditure elasticities are computed as:

(5.5) $$\eta_i = (b_i + \delta w_i)/w_i$$

As exhibited in Table 22, the uncompensated own-price elasticities range from –1.85 (Dannon) to –3.29 (LA yogurt). In particular, the own-price elasticity of Yoplait Healthy Heart is –2.72, while the own-price elasticity for other Yoplait brands is –1.89. Hence, the demand for brand specific yogurt products is elastic. Also, consumers are more price-sensitive to the new phytosterol yogurt product than to the non-phytosterol yogurt brands. The expenditure elasticities vary from 0.07 (Mountain High) to 1.78 (Yofarm).

Table 22.Uncompensated Own-Price, Cross-Price Elasticities and Expenditure Elasticities

	Healthy Heart	Other Yoplait	Breyer's	Colombo	Dannon	LA
Healthy Heart	-2.718 (0.000)	-0.534 (0.718)	0.297 (0.588)	-0.337 (0.414)	1.804 (0.018)	0.128 (0.661)
Other Yoplait	-0.007 (0.796)	-1.895 (0.000)	0.061 (0.060)	0.019 (0.445)	0.189 (0.009)	0.006 (0.756)
Breyer's	0.056 (0.579)	0.545 (0.084)	-2.496 (0.000)	0.015 (0.900)	-0.031 (0.905)	0.055 (0.554)
Colombo	-0.130 (0.424)	0.450 (0.366)	0.041 (0.868)	-2.609 (0.000)	1.005 (0.007)	0.142 (0.297)
Dannon	0.055 (0.011)	0.388 (0.000)	0.012 (0.769)	0.075 (0.006)	-1.852 (0.000)	0.016 (0.515)
LA	0.068 (0.614)	0.462 (0.336)	0.178 (0.451)	0.180 (0.261)	0.401 (0.330)	-3.290 0.000
Mountain High	-0.297 (0.065)	1.340 (0.001)	0.036 (0.848)	-0.114 (0.389)	0.332 (0.111)	0.108 (0.166)
Stonyfield Farm	0.069 (0.323)	0.325 (0.088)	0.043 (0.626)	0.110 (0.101)	0.325 (0.004)	0.074 (0.090)
Wells Blue Bunny	-0.212 (0.197)	1.226 (0.004)	0.466 (0.030)	-0.051 (0.734)	-0.180 (0.528)	-0.075 (0.494)
Private Label	-0.005 (0.927)	0.888 0.000	0.057 (0.372)	-0.094 (0.045)	0.357 (0.000)	0.129 (0.000)
Yofarm	-0.225 (0.079)	1.108 (0.001)	0.130 (0.388)	-0.115 (0.266)	0.259 (0.202)	-0.056 (0.498)
All Other	0.123 (0.057)	0.100 (0.542)	0.081 (0.286)	0.200 (0.000)	0.417 (0.000)	0.006 (0.880)

Table 22. Continued

	Mountain High	Stonyfield Farm	Wells Blue Bunny	Private Label	Yofarm	All Other	Expen-diture
Healthy Heart	-0.583	0.551	-0.429	-0.208	-0.609	1.078	1.560
	(0.056)	(0.363)	(0.196)	(0.845)	(0.078)	(0.076)	(0.026)
Other Yoplait	0.033	0.032	0.047	0.277	0.067	-0.021	1.192
	(0.026)	(0.328)	(0.005)	(0.000)	(0.000)	(0.507)	(0.000)
Breyer's	-0.004	0.038	0.171	0.130	0.073	0.090	1.359
	(0.950)	(0.791)	(0.031)	(0.595)	(0.332)	(0.500)	(0.000)
Colombo	-0.098	0.360	-0.038	-0.811	-0.111	0.705	1.094
	(0.315)	(0.121)	(0.754)	(0.038)	(0.319)	(0.000)	(0.011)
Dannon	0.007	0.075	-0.005	0.185	0.036	0.089	0.920
	(0.552)	(0.006)	(0.778)	(0.001)	(0.025)	(0.001)	(0.000)
LA	0.092	0.325	-0.057	1.283	-0.044	0.041	0.361
	(0.182)	(0.068)	(0.580)	(0.000)	(0.673)	(0.816)	(0.385)
Mountain High	-1.855	-0.163	0.161	0.542	-0.007	-0.158	0.073
	(0.000)	(0.572)	(0.268)	(0.116)	(0.963)	(0.442)	(0.739)
Stonyfield Farm	-0.046	-1.872	-0.068	0.073	-0.117	0.228	0.856
	(0.464)	(0.000)	(0.249)	(0.602)	(0.025)	(0.009)	(0.000)
Wells Blue Bunny	0.136	-0.316	-2.234	-0.230	0.136	0.021	1.314
	(0.321)	(0.211)	(0.000)	(0.536)	(0.260)	(0.918)	(0.000)
Private Label	0.041	0.036	-0.015	-2.142	-0.041	0.027	0.761
	(0.185)	(0.533)	(0.675)	(0.000)	(0.248)	(0.612)	(0.000)
Yofarm	-0.027	-0.424	0.094	-0.449	-2.160	0.085	1.779
	(0.787)	(0.011)	(0.298)	(0.104)	(0.000)	(0.597)	(0.000)
All Other	-0.039	0.226	0.014	0.084	0.047	-1.854	0.594
	(0.348)	(0.005)	(0.735)	(0.487)	(0.311)	(0.000)	(0.000)

Note: The figures in parentheses are the associated p-values.

As shown in Table 23, most of the off-diagonal elements of the compensated matrix of elasticities are positive. This result suggests that by and large, the yogurt brands are substitutes. Importantly, no cannibalization effects exist between Yoplait Healthy Heart and other Yoplait brands. As well, the phytosterol product and existing yogurt brands are independent goods except for Dannon. In this case, Yoplait Healthy Heart and Dannon are substitute products. Statistically significant compensated cross-price elasticities reveal competitors for each yogurt product. To illustrate, chief competitors for non-phytosterol Yoplait listed in terms of degree of substitutability are Dannon, Private Label, Breyer's, Stonyfield Farm, Yofarm, Wells Blue Bunny and Mountain High.

Table 23. Compensated Own-Price and Cross-Price Elasticities

	Healthy Heart	Other Yoplait	Breyer's	Colombo	Dannon	LA
Healthy Heart	-2.707 (0.000)	0.044 (0.977)	0.355 (0.517)	-0.309 (0.450)	2.184 (0.005)	0.151 (0.601)
Other Yoplait	0.001 (0.977)	-1.453 (0.000)	0.106 (0.001)	0.040 (0.108)	0.479 (0.000)	0.024 (0.226)
Breyer's	0.065 (0.517)	1.048 (0.001)	-2.445 0.000	0.038 (0.741)	0.300 (0.241)	0.075 (0.417)
Colombo	-0.123 (0.450)	0.855 (0.108)	0.082 (0.741)	-2.590 (0.000)	1.271 (0.001)	0.159 (0.242)
Dannon	0.062 (0.005)	0.729 (0.000)	0.046 (0.241)	0.091 (0.001)	-1.628 (0.000)	0.030 (0.226)
LA	0.070 (0.601)	0.596 (0.226)	0.191 (0.417)	0.187 (0.242)	0.489 (0.226)	-3.284 0.000
Mountain High	-0.297 (0.065)	1.367 (0.001)	0.039 (0.837)	-0.112 (0.391)	0.350 (0.097)	0.109 (0.158)
Stonyfield Farm	0.075 (0.283)	0.642 (0.001)	0.075 (0.397)	0.125 (0.060)	0.534 (0.000)	0.087 (0.045)
Wells Blue Bunny	-0.203 (0.217)	1.713 (0.000)	0.515 (0.016)	-0.028 (0.850)	0.140 (0.634)	-0.055 (0.610)
Private Label	0.001 (0.991)	1.170 (0.000)	0.085 (0.181)	-0.081 (0.082)	0.543 0.000	0.140 (0.000)
Yofarm	-0.213 (0.097)	1.767 (0.000)	0.197 (0.191)	-0.084 (0.415)	0.692 (0.001)	-0.029 (0.718)
All Other	0.127 (0.049)	0.321 (0.069)	0.103 (0.172)	0.211 (0.000)	0.562 (0.000)	0.015 (0.704)

Table 23. Continued

	Mountain High	Stonyfield Farm	Wells Blue Bunny	Private Label	Yofarm	All Other
Healthy Heart	-0.563	0.643	-0.408	0.012	-0.579	1.178
	(0.065)	(0.283)	(0.217)	(0.991)	(0.097)	(0.049)
Other Yoplait	0.048	0.102	0.064	0.445	0.089	0.055
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.069)
Breyer’s	0.014	0.118	0.190	0.321	0.098	0.177
	(0.837)	(0.397)	(0.016)	(0.181)	(0.191)	(0.172)
Colombo	-0.084	0.424	-0.023	-0.657	-0.090	0.775
	(0.391)	(0.060)	(0.850)	(0.082)	(0.415)	(0.000)
Dannon	0.019	0.130	0.008	0.314	0.053	0.148
	(0.097)	(0.000)	(0.634)	(0.000)	(0.001)	0.000
LA	0.096	0.346	-0.052	1.334	-0.037	0.064
	(0.158)	(0.045)	(0.610)	(0.000)	(0.718)	(0.704)
Mountain High	-1.854	-0.159	0.162	0.552	-0.005	-0.153
	(0.000)	(0.579)	(0.264)	(0.101)	(0.971)	(0.454)
Stonyfield Farm	-0.035	-1.822	-0.056	0.194	-0.101	0.283
	(0.579)	(0.000)	(0.340)	(0.158)	(0.054)	(0.001)
Wells Blue Bunny	0.153	-0.239	-2.216	-0.045	0.160	0.105
	(0.264)	(0.340)	(0.000)	(0.901)	(0.187)	(0.594)
Private Label	0.051	0.081	-0.004	-2.035	-0.026	0.076
	(0.101)	(0.158)	(0.901)	(0.000)	(0.456)	(0.153)
Yofarm	-0.004	-0.319	0.118	-0.199	-2.127	0.199
	(0.971)	(0.054)	(0.187)	(0.456)	(0.000)	(0.211)
All Other	-0.031	0.261	0.023	0.168	0.058	-1.816
	(0.454)	(0.001)	(0.594)	(0.153)	(0.211)	(0.000)

Note: The figures in parentheses are associated p-values.

Top-level Demand Estimation

We estimate the top-level demand equation to determine sensitivity of consumers to yogurt prices as one commodity and to assess whether income has a significant influence on the demand for yogurt products. A stone index is calculated from the brand level. The price index for the overall category of yogurt is tested for endogeneity using the Hausman test. We found that endogeneity problem does not exist and thus used

Ordinary Least Squares (OLS) to estimate the top-level demand model allowing for autocorrelation.

The top-level demand model is

(5.6) $$\log q_t = \beta_0 + \beta_1 \log X_t + \beta_2 \log P_t + \beta_3 Z_t + \varepsilon_t$$

where q_t represents the total quantity of sales, X_t stands for real disposable income, P_t is the price index calculated from brand level estimates, Z_t refers to seasonal dummies and trend variables, and *β's* are the parameters to be estimated. The results are presented in Table 24.

Table 24. Top Level Demand Estimation of Yogurt

Variables	Estimates	Std Error	t-Stats	p-value
Price	-1.3688	0.5303	-2.5810	0.0150
Income	0.0128	0.0018	7.1960	0.0000
Season1	0.0487	0.0173	2.8090	0.0090
Season2	0.0553	0.0170	3.2540	0.0030
Constant	17.6230	0.2503	70.4000	0.0000
ρ	0.2753	0.1602	1.7184	0.0490
R^2	0.8246			

Note: ρ refers to the autocorrelation coefficient.

It is hypothesized that the price elasticity of the overall category for yogurt is not greater than the individual price elasticities of each brand, due to less competition at the category level than at the brand level. Indeed, the estimated own price elasticity is substantially lower at -1.37.

The income elasticity is estimated to be 0.01. Its effect is relatively small compared to other factors such as price and seasonality. The autocorrelation coefficient captures habitual effects. It is positive and significant at 5% level. It may indicate that consumers are more likely to purchase yogurt if they used to consume it.

Season1 and *season2* represent quarterly dummies; they are intended to capture seasonal effects on the consumption of yogurt. The data available run through three quarters, therefore only two dummies are used in the model.

Consumer Welfare

The development of an empirical methodology to estimate the welfare change resulting from price changes can be traced to Hicks' (1942) compensating variation measure. Hausman (1981) developed a closed-form solution for measuring compensating variation under standard linear or log-linear demand functions. More recently, Hausman (1997) showed that the welfare effect of the introduction of a new product is equivalent to the welfare effect of a price drop from the product's "virtual price," the price that sets its demand to zero, to its current price. Subsequently, researchers have examined the welfare effects of other new products in traditional markets, using similar or more refined models. Examples include Hausman (1997b), Nevo (2001), Petrin (2001), and Hausman and Leonard (2002).

As discussed above, we estimate the price effects as well as the variety effects to calculate the competitive or consumer welfare effects. By simple transformation, the price effect and variety effect can be expressed separately as follows (Hausman and Leonard, 2002):

$$
\begin{aligned}
CV &= e(p_1, p_n, r, u_1) - e(p_0, p_n^*(p_0), r, u_1) \\
&= \left[e(p_1, p_n, r, u_1) - e(p_1, p_n^*(p_1), r, u_1)\right] \\
&+ \left[e(p_1, p_n^*(p_1), r, u_1) - e(p_0, p_n^*(p_0), r, u_1)\right] \\
&= -(VE + PE)
\end{aligned} \tag{5.7}
$$

where p_0 and p_1 are price vectors of existing products before and after the introduction of the new product, and p_n stands for the price of the new product. p_n^* represents the reservation price of the new product, the price when the demand for the new product is restricted to be zero and prices of all existing brands are held constant. The first bracket shows the variety effect, the increase in consumer welfare due to the availability of the new product; the second one denotes the price effects - the change in consumer welfare due to increasing price competition created by the new product.

In this section, we will describe in detail how we calculate the price effects, both directly and indirectly, and the variety effects.

Direct Price Effects

The advantage of using the direct method is that we do not have to assume a demand structure in order to estimate the price effects. However, this method requires data before and after the introduction of the new product. Consequently, we divided our data into two periods consisting of 72 observations before the introduction and 36 observations after the introduction of Yoplait Healthy Heart yogurt. We then estimate the following general equation for each of the twelve yogurt brands (excluding Yoplait Healthy Heart):

(5.8) $\ln P_{it} = f$ (trend, seasonality, post-introduction indicator variable)

The subscript *i* refers to the existing brand and the subscript *t* refers to the weekly time period. Therefore, the log of prices is regressed linearly on a set of trend variables, seasonal dummies and the post-introduction indicator variable. This procedure is quite similar to that used by Hausman and Leonard (2002) in looking at the competitive effects of new product introduction in the bath tissue industry.

The post-introduction indicator variable equals one after the introduction of phytosterol-enriched product and zero for all the periods before the introduction. The coefficients associated with this post-introduction indicator variable relate ultimately to the percentage change in price of the existing brand after the introduction of the phytosterol-enriched product. The mathematical relationship for this percentage change is given as

(5.9) $\left(e^{\hat{b}} - 1\right) \times 100\%$

where $\hat{b}$ is the estimated coefficient associated with the post-introduction indicator variable.

The price effects of the introduction of Yoplait Healthy Heart on existing brands are mixed as shown in Table 25. Its introduction has no statistically significant effect on Colombo, LA yogurt and Private Label yogurt products. The price of Yofarm decreases by 2.37% after the introduction of the phytosterol-enriched Yoplait Healthy Heart. Effects of its introduction on the prices of the remaining brands are positive.

Price declines for these brands after the introduction of Yoplait Healthy Heart range from -1.72% (Dannon) to -6.70% (all other branded yogurt products).

Direct price effects are then approximated by summing up the product of quantity and the corresponding post-introduction price changes for each brand. The direct price effect of the introduction of Yoplait Healthy Heart is estimated to be $679,864.

Table 25. Direct and Indirect Estimates of the Price Effects of the Introduction of the Phytosterol-Enriched Yoplait Healthy Heart on the Existing Brands

Brand	Direct Price Change After Introduction (%)	Direct Price Effects	Indirect Price Change After Introduction (%)	Indirect Price Effects
Other Yoplait	2.73	298,056	2.80	305,509
Breyer's	3.05	48,984	-5.84	-93,902
Colombo	-2.50	-15,620	-2.24	-14,003
Dannon	1.72	130,051	3.19	241,544
LA Yogurt	0.00	14	0.43	2,654
Mountain High	2.96	15,239	-16.87	-86,844
Stonyfield Farm	2.95	47,303	2.28	36,549
Private Label	0.18	12,991	0.08	5,771
Wells Blue Bunny	2.08	9,982	0.17	820
Yofarm	-2.37	-12,494	0.64	3,391
All Other Brands	6.70	145,358	-2.71	-58,804
Total Price Effects	-	679,864	-	342,685

Note: Price effect is calculated by multiplying price change by the average quantity for each brand. For example, the direct price change for Other Yoplait is 2.73%, and the average sales for Other Yoplait is 10,899,150 pints, so the direct price effect for Other Yoplait is 298,056 = 2.73% * 10,899,000.

Indirect Price Effects

Although the direct method is preferred due to its straightforwardness, it requires pre-introduction data that are not always available. The indirect method provides a way to evaluate the changes in consumer welfare with the use of only post-introduction data. The indirect method considers how consumer welfare will change if the new product were removed from the market after its introduction. We use the estimated demand system discussed previously, along with an assumed model of competition (i.e., Nash-Bertrand) to estimate indirectly the price effects of the introduction of the phytosterol-enriched product.

Suppose there are *n* firms producing m brands of yogurt. Consider the firm that produces the first *k* products. Under the Nash-Bertrand assumption, it maximizes profit, taking the prices of other brands as given. The first order condition for the firm is,

$$(5.10) \quad w_i(p_1,\ldots,p_n) + \sum_{j=1}^{k} \left[(p_j - c_j)/p_j \right] w_j(p_1,\ldots,p_n) e_{ji}(p_1,\ldots,p_n) = 0 \forall i = 1,\ldots,k$$

where w_i denotes the expenditure share of i^{th} brand, e_{ji} represents the demand elasticity of j^{th} brand with respect to price of i^{th} brand. Each of the firms has a set of first-order conditions similar to equation (9). The marginal costs are obtained by solving these equations simultaneously with the estimated elasticities and evaluated at the means of prices and expenditure shares. The estimated price-cost margins are presented in Table 26. The estimates range from 29.1% (Yoplait Healthy Heart) to 54.0% (Dannon). The estimates are relatively similar among the brands with the exception of Yoplait Healthy Heart and LA yogurt. The price-cost margins may reflect the capability of a firm to command a high mark-up over its marginal cost.

Table 26. Estimated Price-Cost Margins

Brands	Estimated Marginal Costs	Average Prices	Margins (%)
Yoplait Healthy Heart	1.2015	1.6944	29.09
Other Yoplait	0.8244	1.7400	52.62
Breyer's	0.7156	1.1941	40.07
Colombo	0.8814	1.4292	38.33
Dannon	0.7570	1.6451	53.99
LA yogurt	0.8667	1.2453	30.40
Mountain High	0.5959	1.2930	53.91
Stonyfield Farm	0.8760	1.8802	53.41
Wells Blue Bunny	0.8130	1.4718	44.76
Private Label	0.5432	1.0186	46.68
Yofarm	0.9792	1.8234	46.30
All Other Brands	0.6553	1.4231	53.95

The variation in the estimated marginal costs across brands may reflect quality gaps. Barsky et al. (2001) suggested that it might be due to differences in "physical quality", "production method" or "marketing cost". However, they added that the appropriateness of these assumptions might differ across product categories.

Interestingly, Yoplait Healthy Heart has the highest marginal cost but the lowest price-cost margin. This result may suggest that this brand is not as profitable to the manufacturer as other Yoplait products, assuming fixed mark-ups.

With the estimated marginal costs, we then calculate the virtual prices of brands in the absence of the new product. To do so, we force the demand for the new product to be zero and solve the first order conditions. The indirect estimated price effects are presented along with the direct price effects in Table 24. The indirect price effects of the introduction of Yoplait Healthy Heart are not similar to the direct price effects.

Variety Effect

The variety effect, evaluated at the post-introduction prices of all existing brands except Yoplait Healthy Heart, is the increase in the expenditure function that would result from raising the price of Yoplait Healthy Heart from its actual level to its virtual level,

(5.11) $$VE = E\left[p_1, p_K^*(p_1), u_1\right] - E\left[p_1, p_K(p_1), u_1\right]$$

First, before we can estimate the variety effect, we need to calculate the virtual price of Yoplait Healthy Heart by restricting its share to zero, holding the prices of remaining brands at their average actual level. The virtual price is estimated to be at $1.70 per pint, a 0.52% increase from its actual level. As shown by Hausman (1981), the variety effect can be calculated using:

(5.12) $$VE = \left[\frac{(1-\beta_1)}{(1+\beta_2)X^{\beta_1}}\left[P\left(p_1, p_K^*(p_1)\right)^{\left(\beta+\beta_2 \log P\left(p_1, p_K^*(p_1)\right)\right)} - y\right] + X^{1-\beta_2}\right]^{\frac{1}{(1-\beta_1)}} - X$$

where β_1 is the coefficient associated with disposable income in the top level equation; β_2 is the coefficient of the industry price index in the top level equation (6) and β refers to the remainder of the top level equation. $\underline{X}$ is disposable income after the introduction and $\underline{Y}$ is the total expenditure of the yogurt category. $P\left(p_1, p_K^*(p_1)\right)$ is the total industry price index evaluated at the existing brands' actual prices and Yoplait Healthy Heart virtual price. The variety effect of the introduction of Yoplait Healthy Heart is estimated at $ 26,070,429, much larger than the magnitude of price effects.

Total Compensating Variation (CV)

The overall effect of the introduction of Yoplait Healthy Heart on consumer welfare is the sum of the variety effect and the price effect. It can be expressed as

$$(5.13) \qquad CV = \left[\frac{(1-\beta_1)}{(1+\beta_2)X^{\beta_1}} \left[P\left(p_0, p_K^*\right)^{\left(\beta + \beta_2 \log P\left(p_0, p_K^*\right)\right)} - y \right] + X^{1-\beta_2} \right]^{\frac{1}{(1-\beta_1)}} - X$$

where $P\left(p_0, p_K^*\right)$ is the overall industry price index evaluated at pre-introduction prices for the existing brands and virtual price of Yoplait Healthy Heart. It is estimated at $26,750,293, accounting for 1.2% of the annual expenditure of the total yogurt category.

Conclusion

To estimate the welfare effects of the introduction of a new phytosterol enriched yogurt product, we estimated a flexible demand system and pricing relationships in the yogurt category using weekly scanner data. Using the Barten synthetic demand system that subsumes the LA/AIDS, the Rotterdam model, the CBS model and the NBR model, we estimate own-price elasticities for phytosterol-enriched brands and non-phytosterol brands to address consumer sensitivity to price changes. We also estimate cross-price elasticities of phytosterol-enriched food products relative to other products within the category to assess degree of substitutability among the products. We find that no cannibalization exists between Yoplait Healthy Heart and other Yoplait brands. The main focus of our paper is the estimation of the effects of a new phytosterol-enriched brand in the yogurt market on consumer welfare. The empirical results indicate that the direct and indirect price effects are similar in magnitude but these effects are small compared to the estimated positive variety effects. Hence, consumer surplus comes mainly from the variety effects. The total welfare effect amounts to roughly $26 million, about 1.2% of the annual expenditure of the yogurt category.

These findings are important since it suggests that consumers do benefit from the introduction of a new healthier yogurt product and that most of these benefits come from the additional choice or variety that consumers accrue from the availability of this new product. With the rising number of new functional foods being introduced in the market, it is important to know if consumers indeed find them beneficial. The same methodology can be used to examine the welfare and competitive effects of other functional food product introductions using scanner data. For example, if these new product introductions do not provide consumer welfare or surplus, then companies may be more hesitant to develop and market similar products in the future. On the other hand, if future studies confirm the existence of large positive consumer welfare from the introduction of these new functional food products, then they would be more motivated to develop and introduce new functional food products. The government may also be more inclined to promote the development and marketing of these new healthier food products to help combat diet-related diseases and the growing obesity epidemic.

Similar to the findings of Hausman and Leonard (2002), the Nash-Bertrand model utilized in this paper provided indirect price effects that are reasonably close to the direct price effects. This result provides some support for the use of the Nash-Bertrand assumption in the analysis of welfare effects in this paper. However, future studies should examine other models of competition to test the robustness of our findings in the yogurt industry.

CHAPTER VI

GENERAL CONCLUSION AND DISCUSSIONS

Our findings from the first essay generally suggest that the market views the phytosterol-enriched products differently from the products without the phytosterol attribute. Our results indicate that although the phytosterol-enriched margarine products, Benecol and Take Control, command noticeably high premiums, their own-price elasticities are not among the highest in the category.

This study provides insights into how the use of scanner data and demand systems analysis can be used to assess the demand of existing functional foods vis-à-vis other competing products. Future studies should replicate our analysis for other product categories to assess the robustness of our findings.

The third essay can be deemed as an extension of the first essay. The main focus of this essay is the estimation of the effects of a new phytosterol-enriched brand in the yogurt market on consumer welfare. With pre- and post-introduction data, we are able to estimate direct price effects and variety effects. In the meantime, with post-introduction data and an assumed demand structure, i.e. Nash-Bertrand, we estimate indirectly the price effects associated with Yoplait Healthy Heart introduction. The empirical results indicate that the indirect price effects is roughly half of the direct effect but these effects are small compared to the estimated positive variety effects. Hence, consumer surplus comes mainly from the variety effects. The total compensating variation amounts to roughly $26 million, about 1.2% of the annual expenditure of the yogurt category.

These findings suggest that consumers do benefit from the introduction of a new healthier yogurt product and that most of these benefits come from the additional choice or variety that consumers accrue from the availability of this new product. If future studies confirm the existence of large positive consumer welfare from the introduction of these new functional food products, then manufacturers would be more motivated to develop and introduce new functional food products, which will in turn benefit consumers more substantially.

Furthermore, our results from the first essay indicate strong substitutability between Benecol and Take Control and weak substitutability among phytosterol and non-phytosterol brands. It is then plausible to assume that consumers purchase these brands most likely on account of the health-related phytosterol attribute. In addition, we showed in the third essay that welfare effects due to the introduction of Yoplait Healthy Heart mainly come from variety effect, which is a function of how close the new product is associated with the existing products in the marketplace. These results imply that adding a functional or healthy attribute to a food product indeed can be a good way of differentiating one's product in the marketplace.

The second essay is somewhat different; it provides a framework to study cannibalization effects using cross-price elasticities from a flexible demand system. Using the case of an introduction of a functional food in the category of orange juice, we showed that conventional market-share-based measures could not fully explain the market share changes before and after the introduction of new product; therefore, they might not provide a complete picture of cannibalization effects since they do not control for possible effects of other factors (e.g., price interactions between brands within the same product category). Given the condition that the total expenditure of the product category does not change, cross-price elasticities from a flexible demand system can be a reliable measure of cannibalization effects.

Our finding also indicate that there are no cannibalization effects between Minute Maid Heart Wise, which are further confirmed by the similar result between Yoplait Healthy Heart and Other Yoplait yogurt products. Given our findings, it may suggest that products with health-attribute may not be in the same market as the "regular" products. Thus, it may provide an incentive for companies to introduce more new products into the category by adding varying health attributes.

With data availability, future studies also can incorporate demographics and advertising expenditures in the analysis. The presence of demographic variables in the models can provide insights into the segments that food marketers can target for specific functional foods. With micro-level data, a researcher will be able to distinguish the new customers and the customers that switch to other brands, thus providing information on market expansion effects. Future research should also replicate our study with other product categories to assess the robustness of our findings.

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