FUNCTIONAL FOODS AS DIFFERENTIATED PRODUCTS

Alessandro Bonanno

Alessandro Bonanno, Department of Agricultural Economics and Rural Sociology The Pennsylvania State University, Armsby Building, 207-D, University Park, PA, 16803

Email of corresponding author: abonanno@psu.edu

THE ECONOMICS OF FOOD, FOOD CHOICE AND HEALTH
1st joint eaae/aaea seminar
EAAE
AAEA Agricultural & Applied Economics Association

2010

Selected Paper
prepared for presentation at the 1st Joint EAAE/AAEA Seminar

"The Economics of Food, Food Choice and Health"
Freising, Germany, September 15 – 17, 2010

Functional Foods as Differentiated Products

Abstract

Food products providing health benefits beyond nutrition, or functional foods, draw consumers' attention and promise growth opportunities for innovator food manufacturers. European functional food manufacturers may be facing future challenges, mainly due to the European Union Regulation (EC) No.1924/2006 regulating food products' health-claims. However, in spite of the interest shown by academics to understand the acceptance of these products no study exists that analyzes the profitability of functional foods. Using a relatively novel methodology – an adaptation of the LA/AIDS model by means of Pinkse Slade and Brett's (2002) distance metric (DM) method – this article treats functional foods as differentiated products and provides estimates of demand and profit margins for both conventional and functional alternatives sold in the Italian yogurt market. The results indicate that, in this market, the demand for functional products is often more inelastic than that for conventional ones and that brand loyalty plays a major role in consumers' adoption of the functional alternatives. Results also suggest that, on average, functional yogurts deliver higher margins than their conventional counterparts, and that the increased profitability is due in large part to the specific presence of the functional attribute.

Key words: Functional Foods, Differentiated Products, Distance Metric, Yogurt

JEL: L15; L25; L66

Functional Foods as Differentiated Products

Consumers' interest for nutraceutical food products (featuring both *nutr*itional and pharm*aceutical* properties) has been growing, particularly for *functional foods*, whose claim is to provide health benefits beyond the traditional nutrients they contain.[1] The growth of the functional foods' market is remarkable: during the period 2004-2007 the sales of fortified and functional packaged goods have exceeded 10% in Western Europe (*The Economist*, 2009), while forecasts project the value of the global market for functional foods to grow by 56% over the period 2007-2013, to reach $128 billion in 2013 (PricewaterhouseCoopers, 2009).

In spite of the growing importance of the phenomenon, little formal research exists on the economics of functional foods (see Sirò et. al (2008) for an exteensive review of the literature on functional foods). Most of the existing research focuses on understanding consumers' attitudes toward functional products using survey data rather than using actual observed purchasing decision. A common finding of these studies is that consumers with a positive attitude towards functional foods also have a clear understanding and a positive perception of the health benefits they provide (see for example Urala and Lätheenmäki 2003, 2004, and 2007; Verbeke 2005; Labrecque et al. 2006).[2] Also, survey-based studies have found that consumers show high willingness to pay for food with health-enhancing features and/or additional health properties (see for example West et al. 2002; Larue et al. 2004; Markosyan et al. 2007).

However, higher prices may be one of the major hurdles for both consumers' acceptance and buying intention of these products (Childs and Poryzees, 1997). As a consequence, if functional foods' manufacturers fail in their differentiation strategy (*i.e.* if the own- and cross-prices elasticities of demand are large), consumers may be less likely to purchase more expensive functional alternative and/or more likely to switch to the conventional ones. Surprisingly, to date, no study has investigated consumers' actual purchase decisions of functional foods and the role of prices in such decisions.

Understanding consumers' purchasing patterns for functional and conventional alternatives is of crucial importance to evaluate the incentives motivating food manufacturers to develop a line of functional products. In general, functional foods are sold as differentiated products by large food manufacturers with the objective to attract a new consumer base and, often, to revitalize mature segments (Heasman and Mellentin, 2001). If on the one hand the higher margins gained from selling functional products help revive mature segments, on the other hand they are necessary to recover 1) the large R&D costs incurred in the development of the functional attribute,[3] 2) high marketing costs, and 3) those diseconomies of scope which may arise from the excessive length of the product lines (Draganska and Jain, 2005)[4] and from the failure to support the already existing core products (Herath et al. 2008).

Functional food manufacturers emphasize that health benefits obtained from repeated consumption, to both increase the likelihood of attracting (and retaining) consumers with higher willingness to pay as well as brand loyalty, aiming to set high barriers to entry and successful differentiation. However, if brand loyalty is not achieved, this strategy may be risky. In markets characterized by consumers' experiencing switching costs, firms compete *head-to-head* and match their competitors' strategies (Klemperer, 1995), which could result in other food manufacturers developing products with similar functional attributes to those of the successful players in the market. In sum, functional foods manufacturers aim to achieve higher margins capitalizing on repeated purchases and brand loyalty. In spite of the proliferation of functional food products, no study has so far investigated functional foods' profitability and the extent of their differentiation.[5]

The lack of formal analysis of the potential profitability of functional foods is surprising especially in light of the rapid changes that the European functional food industry is experiencing with the implementation of the Regulation (EC) No. 1924/2006, 20 December 2006, regulating food products' health claims. Food industry pundits are concerned that the lack of transparency of the protocols used by the EFSA review panel may create a climate of uncertainty which could jeopardize the future innovation and growth of the European food industry (Starling, 2009).[6,7] The burden of the uncertainty deriving by the implementation of the Reg. (EC) No. 1924/2006 adds to the list of costs that manufacturers experience when investing in the development and marketing of functional products described above.

In order to provide a better understanding of the dynamics that characterize the market of functional foods, this study aims to 1) analyze the role of product characteristics on consumers' demand and price sensitivity for functional and conventional products; 2) to investigate the determinants of consumers' switching decision between conventional and functional alternatives (and vice versa) and; 3) to provide a first assessment of the profitability of functional foods.

To achieve these objectives, Deaton and Muellbauer's (1980) LA/AIDS model is modified following Rojas and Peterson's (2008) adaptation of Pinkse, Slade, and Brett's (2002) Distance Metric (DM) method, and the model applied to a scanner database of yogurt purchases in sixteen Italian regions including eighteen conventional and twelve functional products.[8] The DM method follows the concept that products more distant in a characteristics space are less likely to be substitutes to one another. This method allows for a flexible substitution pattern across products while keeping the analysis tractable (e.g., only one equation needs to be estimated, even when a large number of products/brands are considered, and the size of the parameter space is also heavily reduced). The Italian yogurt market represents a good case study since large yogurt manufacturers operating in this market (Danone, Parmalat and Nestle) have heavily invested in adding new product lines including mainly functional products. Table 1 contains a list of examples of functional yogurts sold in the Italian market during the period 2004-2007.

The results show that Italian consumers of functional yogurts are on average less price sensitive than those purchasing conventional ones, and that brand loyalty plays a major role in this market. Also, if motivated by a price increase, intra-brand shifting between functional and conventional yogurts is more likely than across brands, suggesting that the presence of different functional attributes across brands enhances switching costs. Lastly, the results suggest that, in most cases, functional yogurts generate higher margins than their conventional counterparts, principally due to the functional attributes themselves.

The Model

The demand for yogurts in the Italian market is modeled following the Linear Approximated–Almost Ideal Demand System developed by Deaton and Muellbauer (1980). Let $j \in (1,...,J)$ and $t \in (1,...,T)$ be product and time indexes, respectively. Let q_{jt} be the retail-level quantity demanded for product j at time t and p_{jt} its price, the total expenditure for yogurt at time t is $x_t = \sum_j q_{jt} p_{jt}$, so that

$$(1) \qquad w_{jt} = a_j + \sum_{k=1}^{J} b_{jk} \log p_{kt} + \beta_j \log \frac{x_t}{P_t^L} + e_{jt},$$

where $w_{jt} = \frac{q_{jt} p_{jt}}{x_t}$ is product's j expenditure share at time $t, \log P_t^L$ is Moschini's (1995) Laspeyers-type Price Index ($\log P_t^L \approx \sum_{j=1}^{J} w_j^0 \log p_{jt}$ where $w_j^0 = T^{-1} \sum_{t=1}^{T} w_{jt}$), the αs, bs and βs are parameters to be estimated and e_{jt} is an error term. After imposing all the restrictions dictated by theory,[9] the estimation of a LA/AIDS demand system requires estimating *J*-1 equations and *J*(*J*-1)/2 cross-price parameters which, for large *J*, becomes a hardly manageable process.

To circumvent the dimensionality issue, the cross price parameters b_{jk}s are assumed to be functions of the distance in attribute space between product *j* and *k*. This approach, the Distance Metric (DM) method, originally developed by Pinkse, Slade and Brett (2002) to analyze spatial price competition in the U.S. wholesale gasoline market, has been first applied to the analysis of demand in Pinkse and Slade's (2004) study of the U.K. beer market. The methodology followed in this paper draws largely from Rojas (2008), Rojas and Peterson (2008) and in part from Pofahl and Richards (2009) applications of the DM method to the LA/AIDS model (which will be referred to as DM-LA/AIDS).

In this application of the DM method, let Z_j^C and Z_j^D be sets of product's *j* attributes, measured in continuous space (calories, fat content etc…), and in discrete space (brand, flavors, presence of a functional attribute), respectively. Let δ_{jk}^C and δ_{jk}^D be the measures of closeness between products *j* and *k*, function of continuous and discrete attributes, respectively. Following Pinkse and Slade (2004), Rojas (2008), and Pofahl and Richards (2009), δ_{jk}^C is specified as a function of the Euclidean distance in characteristics space between product *j* and *k*:[10]

$$\text{(2)} \qquad \delta_{jk}^{C} = \frac{1}{1 + 2\sqrt{\sum_{l}(z_{jl}^{C} - z_{kl}^{C})^2}},$$

where z_{jl}^{C} (z_{kl}^{C}) is the *l*-th continuous attribute of product *j* (*k*). Let z_{jl}^{D} be an indicator variable such that z_{jl}^{D} ={1 if product *j* shows characteristic *l*; 0 otherwise}. The expression for δ_{jk}^{D} is:

$$\text{(3)} \qquad \delta_{jk}^{D} = \begin{cases} 1 \text{ if } \left| z_{jl}^{D} - z_{kl}^{D} \right| = 0 \\ 0 \text{ if } \left| z_{jl}^{D} - z_{kl}^{D} \right| = 1. \end{cases}$$

It should be pointed out that δ_{jk}^{C} and δ_{jk}^{D} play two very different roles: δ_{jk}^{C} is a global measure of product closeness and it will show small, but non-zero values even for products that are very dissimilar. δ_{jk}^{D} is instead a local measure of closeness which takes the value of 1 if *j* and *k* have the same attribute (i.e. they are *neighboring* products), 0 otherwise.[11] Before proceeding, one technical note regarding equation (2) is needed. For continuous attributes measured in different units, their values (or their distances) should be normalized to one to ensure that all the attributes have the same weight in determining closeness. Since in this analysis all continuous attributes will be expressed in the same unit, so no rescaling will be needed.

Using the closeness measures δ_{jk}^{C} and δ_{jk}^{D} the cross-price parameter portion of the LA/AIDS is reformulated as follows:[12]

$$\text{(4)} \qquad \sum_{k=1}^{J} b_{jk} \log p_{kt} = b_{jj} \log p_j + \lambda_j \sum_{k \neq j}^{J} \delta_{jk}^{C} \log p_{kt} + \varphi_j \sum_{k \neq j}^{J} \delta_{jk}^{D} \log p_{kt},$$

which gives $b_{j1} = \lambda_j \delta_{j1}^{C} + \varphi_j \delta_{j1}^{D}, ..., b_{jn} = \lambda_j \delta_{jn}^{C} + \varphi_j \delta_{jn}^{D}$, where φ_j and λ_j are parameters to be estimated. Additionally, following Rojas (2008) and Rojas and Peterson (2008), symmetry is imposed to the cross-price parameters by assuming $\lambda_1 = \lambda_2 = ... = \lambda_J = \lambda$ and

$\varphi_1 = \varphi_2 = ... = \varphi_J = \varphi$ .Since $\delta^C_{jk} = \delta^C_{kj}$ and $\delta^D_{jk} = \delta^D_{kj}$, one has $\lambda\delta^C_{jk} + \varphi\delta^D_{jk} = b_{jk} = b_{kj} = \lambda\delta^C_{kj} + \varphi\delta^D_{kj}$, which reduces the total number of cross-price parameters to be estimated from $J(J\text{-}1)/2$ to 2.

Following Pinkse and Slade (2004), Rojas (2008), and Rojas and Peterson (2008), product attributes are interacted with own-price, intercept and expenditure coefficients so that only one equation needs to be estimated. Imposing $a_j = a_0 + \sum_n a_n z^a_{jn}$, $b_{jj} = \gamma_0 + \sum_l \gamma_l z^b_{jl}$ and $\beta_j = \beta_0 + \sum_m \beta_m z^\beta_{jm}$, where z^a_j , z^b_j and z^β_j are different subsets of product's *j* attributes,[13] the final specification of the DM-LA/AIDS model is:

$$
\begin{aligned}
w_{jt} &= a_0 + \sum_n a_n z^a_{jn} + \log p_{jt}\left(\gamma_0 + \sum_l \gamma_l z^b_{jl}\right) \\
&\quad + \lambda\sum_{k\neq j}^{J} \delta^C_{jk} \log p_{kt} + \sum_D \varphi^D \sum_{k\neq j}^{J} \delta^D_{jk} \log p_{kt} + \log\frac{x_t}{P^L_t}\left(\beta_0 + \sum_m \beta_l z^\beta_{jm}\right) + e_{jt}.
\end{aligned}
\tag{5}
$$

where the discrete closeness measures are indexed as *D*={Brand (*Br*); Flavor (*Fl*); Drinkable (*Dr*); Functional (*H*)}.

The sign and magnitude of the estimated $\varphi^D s$ characterizes the structure of consumers' switching behavior motivated by a price increase. For example, a large and positive estimate of φ^{Br} would suggest that brand loyalty plays a major role in this market, since consumers would respond to an increase in the price of the product they currently purchase by switching to a different product by the same manufacturer. Important for this analysis is the sign and the magnitude of φ^H , the coefficient associated with closeness in the functional attribute. If $\varphi^H > 0$, consumers will be more likely to switch within the same types of yogurts (either conventional or functional). If instead $\varphi^H < 0$ consumers will be more likely to switch from a functional to a conventional yogurt (or vice versa). The other coefficients have similar interpretations.

The Marhsallian own- (η_{jj}) and cross- (η_{jk}) price elasticities are calculated as:

(6 - a) $\eta_{jj} = -1 + \frac{\gamma_0 + \sum_l \gamma_l z_{jl}^b}{\overline{w_j}} - \left(\beta_0 + \sum_m \beta_l z_{jm}^\beta \right)$ and

(6 - b) $\eta_{jk} = \frac{\lambda \delta_{jk}^{SFP} + \sum_d \varphi^D \delta_{jk}^D}{\overline{w_j}} - \left(\beta_0 + \sum_m \beta_l z_{jm}^\beta \right) \frac{\overline{w_k}}{\overline{w_j}}$,

where $\overline{w_j} \left(\overline{w_k} \right)$ is product *j*'s (*k*) expenditure share measured at the sample average. Comparing the own- and cross- price elasticities for functional and conventional yogurts, will help understanding the role of price on consumers' acceptance of functional products in presence of conventional alternatives.

In order to assess the profitability associated with functional yogurts, one needs to specify a supply-side relationship for the firms operating in the Italian yogurt market and use the estimated demand coefficients to calculate profit margins. Let Y_n be the set of yogurts produced by manufacturer *n*. Assume manufacturer *n* maximizes its profits by (jointly) setting prices for all the products it produces:

(7) $\max_{p_j} \pi_n = \sum_{j \in Y_n} q_j (p_j - c_j) - F_j$;

where c_j is product's *j* (constant) short-run marginal cost and F_j is its fixed costs. Assuming that prices are outcome of a Bertrand-Nash equilibrium, the optimization problem in (7) will lead to a vector of FOCs which can be expressed as:

(8) $p - c = \Omega^{-1} q(p, z)$.

Each element of the matrix Ω is defined as

(9) $\Omega_{jk} = \Omega^*{}_{jk} \Delta_{jk}$,

where Ω_{jk}^* and Δ_{jk} are respectively $\Omega_{jk}^* = \begin{cases} 1 & if \quad k, j \in Y_n \\ 0 & otherwise \end{cases}$; and $\Delta_{jk} = \frac{\partial q_j}{\partial p_k}$.

The matrix Ω^* represents, in the context of a multi-product Bertrand pricing behavior, the ownership matrix; while the elements of Δ are partial derivatives of the demand equation with respect to the vector of prices. Equation (8) defines implicitly the expression of the Price Cost Margins (PCM) for each product $j \in Y_n$. Following Rojas and Petersen (2008), one can obtain different values of the PCMs combining the estimated parameters of the DM-LA/AIDS with different structures of Ω^*. Two scenarios will be considered here, the first assumes that the price of each yogurt is the outcome of a single-product Nash Bertrand equilibrium (or that $\Omega^*_{jk} = 1$ for *j*=*k* and 0 otherwise). Following Draganska and Jain's (2006) finding that manufacturers who offer multiple product lines tend to choose uniform pricing strategies inside the same product line, an alternative multi-product Nash-Bertrand pricing strategy will be simulated considering the existence of three product-lines, conventional spoonable, drinkable functional and spoonable functional (formally: $\Omega^*_{jk} = 1 \; \forall j,k \in Y_n$, $z_j^H - z_k^H = 0$, and $z_j^{Dr} - z_k^{Dr} = 0$).

As introducing a functional component is a long-run strategic decision, one could differentiate (8) w.r.t. z_j^H, and obtain a comparative static expression determining the marginal variation in (short-run) profitability when a functional attribute is added to a product. Under the assumption of single-product Nash-Bertrand pricing, one could obtain an estimable form of a comparative static expression for a change in the formulation of a product. Since the functional attribute is represented by an indicator variable, one cannot differentiate (8) for such characteristic directly (see Appendix 1 for the derivation of such similar measure for continuous characteristics). However, one can measure such variation as follows:

$$(10) \qquad \Delta\% PCM_j^H = \frac{PCM_j - PCM_j^*}{PCM_j} = -\eta_{jj}\left[-\frac{1}{\eta_{jj}} + \frac{1}{\eta_{jj}^*}\right] = -\frac{\eta_{jj} - \eta_{jj}^*}{\eta_{jj}^*}$$

where η_{jj}^{*} represents the simulated own-price elasticity of demand for a functional yogurt "stripped" of the functional component. An example may clarify. Assume that both the own-price parameter and the expenditure parameters of the functional alternative *j* are shifted by an unspecified continuous characteristic z_C, and the functional indicator z_H. Then, η_{jj} and η_{jj}^{*} will be $\eta_{jj} = -1 + \frac{\gamma_0 + \gamma_C z_C + \gamma_H z_H}{\overline{w}_j} - \left(\beta_0 + \beta_C z_C + \beta_H z_H\right)$ and $\eta_{jj}^{*} = -1 + \frac{\gamma_0 + \gamma_C z_C}{\overline{w}_j} - \left(\beta_0 + \beta_C z_C\right)$ so that one has $\Delta\%PCM_j^H = \left[\frac{\gamma_H}{\overline{w}_j} - \beta_H\right]\left[-1 + \frac{\gamma_0 + \gamma_C z_C}{\overline{w}_j} - \left(\beta_0 + \beta_C z_C\right)\right]^{-1}$.

Equation (10) measures the percentage of profit margin of a functional yogurt which is directly attributable to the functional component, under the single-product Nash-Bertrand assumption, and due to this fact, it may be interpreted as a measure of the lower bound of the actual increase in margins under the other pricing structure. Since consumers of functional products are expected to be less price sensitive than those of conventional ones, i.e. γ_H is expected to be positive, equation (10) will show positive sign, with the caveat that the simulated elasticity $\eta_{jj}^{*} < 0$ and $\gamma_H - \beta_H \overline{w_j} > 0$. Alternatively, one could interpret (10) as the profitability that a yogurt manufacturer would renounce to if the functional products were stripped of the health attribute, leaving everything else unchanged.

Data and Estimation

Equation (5) is estimated using primarily a scanner database provided by the Food Marketing Policy Center at the University of Connecticut[14] and the Univeristà Cattolica del Sacro Cuore di Piacenza, Italy, supplied originally by Information Resources Incorporated (IRI). The data include twenty-four monthly observations of yogurt sales (quantities and values) for the period January 2004 – December 2005 in Hyper- and Super-markets located in sixteen Italian IRI regional markets to cover most of the national territory,[15] for a total of 384 market combinations. Thirty products[16] are identified as combination of vendors (Danone, Granarolo, Nestle, Muller and Parmalat) which are referred below as brands, flavor (plain, fruit and other flavors), fat content (skim and whole), drinkable versus non-drinkable, and the presence (or absence) of a functional attribute, for a total of 11,520 usable observations. Volume and value of sales are used to calculate prices in €/Kg; the database contains also average volume per unit and a measure of market penetration (average number of items per product per store).

The continuous product characteristics used in the analysis are protein, carbohydrate, and fat content (all referred to 100g of product). Attributes' data were collected from the manufacturers' websites or, when not available, form www.ciao.it, a website where Italian consumers share opinions and information on purchase experiences, reporting at times the nutritional content of food products as they appear on the nutritional labels.[17] Table 1 presents summary statistics of the data for the thirty products considered in the analysis, including product characteristics, price and expenditure shares. Other product characteristics are average volume per unit (Kilogram/unit) and a proxy for market coverage (average number of items per store).

Monthly and regional dummies are included in the estimation to capture seasonal variations in yogurt consumption, and unobservables across regions, respectively. Furthermore, following Blundell and Robin (2000) and Dhar, Chavas and Gould (2003) category expenditure is treated as endogenous. Following Blundell and Robin (2000) and Dhar *et al.* (2005) expenditure is instrumented by regressing it on median household income (from ISTAT), its squared term, a (monthly) time trend and region dummies.

Equation (5) is estimated via Generalized Method of Moments (GMM) using cost variables to account for the endogeneity of price. The variables used as instruments are: farm-level milk price (national, monthly, €/l) by the Istituto per lo Studio dei Mercati Agricoli (ISMEA); a cost index of retail activities (regional, annual) and retail workers per capita earnings (regional, annual, € .000) by the Osservatorio Italiano del Commercio; the industrial price of heating oil (national, monthly, €/hl) by the Ministero dello Sviluppo Economico, Statistiche dell'Energia; the commercial price of electricity at the source (regional, monthly, €/Mw) by the Gestore del Mercato Elettrico Italiano and the producer price index for the dairy industry (national, monthly) by ISTAT. The estimation was executed using STATA v. 10.

Empirical Results

The empirical results summarized below and presented in table 3, represent the results of three different specifications of equation (5). Average volume per unit and market penetration are used to shift the intercept (z_j^a), while different product characteristics shift the own-price and expenditure parameters. In the first specification, which will be referred to as the full model, the vector of log-price shifters z_j^b are fat content, flavor indicators (fruit, other flavors and plain), the functional indicator and brand (vendor) indicators, while the vector of category expenditure shifters z_j^β are protein, carbohydrate content, flavor indicators (fruit, other flavors and plain), the functional indicator and brand (vendor) dummies. Several alternative specifications were estimated departing from the full model by excluding different shifters, based upon significance and their contribution to the Variance Inflation Factor, which was monitored to mitigate problems of potential collinearity in the model. The results of three specifications of the model, the full model, one intermediate specification and a streamlined, restricted specification are presented in the text, although several alternative specifications of the DM-LA/AIDS specifications were estimated and the results available upon request.

From the summary statistics of the estimated models presented in Table 3 it emerges that the three specifications of the DM-LA/AIDS models show relatively high R-squared (0.7825, 0.7574, and 0.7470) respectively, and the orthogonality condition of the overidentifying instruments satisfied, in all the models with the *p*-value of the Hansen (1982) *J*-statistic being 0.0914, 0.0962, and 0.1003, respectively. Lastly, the average VIFs of the variables in the three models are 48.53, 15.19, and 6.37, showing that the restricted model's result are likely not to be affected by multi-collinearity.

Estimated Coefficients

The baseline own-price coefficients are all negative and significant across specifications, and qualitatively similar to one another. The estimated coefficients are, respectively -0.0634 (significant at the 5% level), -0.0521 (significant at the 10% level), and -0.0657 (significant at the 1% level). The coefficients associated with the interaction of log-price with the plain and fruit indicators are not statistically significant. The coefficient of the interaction of price with the functional indicator is positive and significant in the three specifications, with the coefficients being similar in the full and intermediate specification (0.0195 and 0.0199, respectively) and 25% smaller in the restricted model (0.0156). These results indicate that, everything else constant, Italian consumers are less price sensitive for functional yogurts than for conventional ones. The interactions of the own-price with the vendor indicators (Granarolo, Parmalat and Muller) are negative and significant (with the exception of the Muller indicator in the full specification), indicating that Danone, the market leader and Nestle, the other innovator in the Italian market, may benefit from consumers showing lower price sensitivity for their products.

The behavior of the cross-price closeness measures is slightly different across specifications. The estimated coefficient associated with δ_{jk}^{C} are positive and significant ranging from 0.0017 in the full-model to 0.0046 in the restricted model, indicating that consumers respond to price increases by switching to products with similar nutritional profiles. Among the discrete closeness measures, closeness in brands emerges as one of the strongest determinant of the substitution pattern, suggesting that, when motivated by a price increase, Italian consumers of yogurt tend to switch within products of the same manufacturer, pointing to a substantial level of brand loyalty in this market (the coefficients are approximately 0.003 and significant at the 1% level in the three specifications). Closeness in functional attribute is also relatively strong determinant of substitution, although the estimated coefficient associate with it is significant in only two of the specifications; this suggests that Italian yogurt consumers will tend to buy products in the same sub-category, or, in other words, that price is not a large motivator for switching between functional and conventional yogurts.

The role of closeness in flavor is unclear, as its coefficient is negative and significant in two of the specifications (-0.0027 in the full model and -0.0109 in the intermediate specification) while in the restricted specification the coefficient is positive but relatively small (0.0008). Closeness in drinkable attributes seems not to affect the substitution across yogurts in two of the specifications, although the negative and statistically significant coefficient for closeness in the “drinkable” attribute (-0.0015) in the restricted model may suggest that, as the prices of a non-drinkable yogurts increases, consumers could be more likely to buy a drinkable alternative (and vice versa). In completing the exposition of the estimated parameters, most of the category expenditure's interactions and the demand intercept's shifters (average volume per unit and coverage) are significant at the 5% level, whit the exception of the interaction of the category expenditure coefficients with protein, the functional indicator and the brand indicator for Muller.

Own-Price Elasticities[18]

Estimates of the own-price elasticties obtained using (6-a) are reported in table 4. The values of estimated elasticities appear on average larger for the full specification, compared to those of the restricted models. The estimated elasticities in the full specification range from -14.79 to -1.43, for an average value of -5.18; the range of the elasticities for the other two models are -11.88 to -1.27 (average -4.34) and -11.01 to -1.43 (average -4.54), respectively. In spite of the different magnitudes across models, the estimates are qualitatively similar: across specifications Danone's functional/drinkable/whole is the product with the least elastic demand, while in the full specification the demand for Granarolo conventional/plain/skim shows the largest values, while Nestle conventional/other flavors/skim shows the largest elasticities of demand in the other two specifications of the model. It should be noted than in the restricted models Granarolo's conventional/plain/skim shows the second largest elasticity after Nestle conventional/other flavors/skim, this last product showing the third largest elasticity in the unrestricted (full) specification.

The estimated own-price elasticities are larger than those obtained in previous analyses of the yogurt market. For example, Draganska and Jain (2006) estimate own-price elasticities of the demand for yogurts in the U.S. ranging from −2.45 to −6.25, while Di Giacomo presents values of elasticities in the Italian yogurt market ranging from -0.88 to -2.66. The different magnitude of the estimates presented in table 4 compared with those in the literature find justifications on two grounds. First, the discussed presented above are obtained using a different method (a nested-logit demand model) and, although different methods should not lead to such dramatically different results, that even in the case of the estimates presented in this paper, the less the structure imposed on the own-price and expenditure parameters, (i.e. less characteristics are interacted with price and expenditure) the smaller the values of the estimated elasticities.[19] Secondly, the estimated elasticities are comparable to other studies that have focused on product categories other then yogurts but used data at a level of disaggregation similar to those used in this analysis (see Pofahl and Richards 2009). [20]

Although accepting the validity of estimated elasticities is subject to the caveats illustrated above, the consistency in direction across model specifications indicates that they can be used to define a roadmap to understand differences in demand for the different types of yogurts in the Italian market. In sum, five patterns emerging from the values in Table 4 are:

1 – *Functional vs. conventional*: demand for functional yogurts show lower values of own-price elasticity than their conventional counterparts, although with some exceptions. Across model specifications, functional plain and "other flavors" yogurts show larger values of own price elasticities than their conventional counterparts, while the same does not apply for fruit yogurts (both Danone's and Parmalat's).

2 – *Drinkable*: functional drinkable yogurts show own-price elasticities of demand below the average values in each of the model specifications, with the exception of Granarolo. In particular Danone's drinkable/whole shows the lowest own-price elasticity across model specifications.

3 – *Brand* (*vendor*): the demand for Danone's yogurts tends to be less elastic than that for other brands, across flavors, fat content and functional properties. For each of the possible flavors (or

texture) considered the demand for Danone's products is less elastic than that of other vendors' with the exception of plain/conventional yogurts, where the "whole" alternative by Muller shows the lowest magnitude of elasticities.

4 – *Flavors*: the demand for plain yogurts show (on average) higher values of elasticity than that for other flavors, for both conventional and functional yogurts alike.

5 – *Fat content*: whole yogurts demand appears to be more inelastic than skim's, across brands and flavors.

PCMs and Contribution of the Functional Component to the PCMs

The Price-Cost Margins calculated under the single product Nash-Bertrand and the multi-product portfolio pricing are reported in table 5, along with the variation in margins as in equation (10). The values illustrated are those for the restricted model; those of the other specifications are available upon request by the authors.

On average, non-drinkable functional alternatives have an estimated PCM of 0.30 under single-product Bertrand, similar to the average margins of conventional alternatives (0.29). Under portfolio-pricing, however, the estimated average margins are larger for functional yogurts (0.62) than for conventional ones (0.52). Muller conventional/fruit/skim shows the lowest margins in both scenarios (0.09 and 0.13 in the single-product Bertrand and portfolio pricing, respectively). Nestle conventional/other flavors shows the lowest margins under the three scenarios (approximately 0.06), while the products showing the largest margins are, respectively in the single-product Bertrand scenario and the portfolio-pricing one, Danone functional drinkable/whole (0.70), and Danone function fruit/skim (0.97). This last result can, however be due to the structure of the simulated portfolio strategy; in fact, under any multi-product Nash-Bertrand portfolio pricing scenario, the margins would tend to become larger as the number of products in each segment increases, as long as the cross-price elasticites are positive. The reader can easily check that the increase in margin is the largest for Danone's yogurts for which there are more products in our sample.

The estimated contribution of the functional attribute to the PCM is substantial, ranging from 9% of Danone drinkable/whole to 25% of Parmalat other flavors/whole. Interestingly enough, the functional attribute impacts more the non-drinkable functional yogurts than the drinkable ones. As these variations in margins are obtained under the Nash Bertrand scenario, and they could therefore represent the lower bound of the actual variations under other pricing scenarios, suggesting that the introduction of a functional attribute can potentially result in a substantial benefit for functional food manufacturers.

Concluding Remarks

As consumers' interest for nutraceutical food products grows, food manufacturers may see the development of functional products as an opportunity to revitalize mature markets. Despite many stated preference studies have found trust and credence being strong determinants of consumers' acceptance of functional foods, these studies have disregarded the fact that these products are often present in the marketplace as differentiated products, and other mechanisms (brand loyalty, switching cost) may impact their likelihood of success.

This article has analyzed the demand for functional and conventional products and their profitability, using the Italian yogurt as a case study via a relatively novel and parsimonious methodology (the Distance Metric method). Results show that brand loyalty plays an important role in the Italian yogurt market and that the success of functional products is heavily influenced by it. Danone, the market leader, benefits largely from this phenomenon, being able to exert high margins for its functional products. Results show also that consumers of functional yogurts tend to be less price sensitive than those of conventional ones and that superior performances are associated with the presence of a functional attribute. Furthermore, both intra-brand and inter-brand substitution across functional and conventional yogurts favors in most cases the products with functional attributes, this result strengthening the existing evidence that consumers show remarkable interest for functional products.

As "switching" between functional products produced by different manufacturers appears unlikely, the yogurt manufacturers operating in the Italian market may be able to expand their consumers' base via introducing new functional products, successfully avoiding sales cannibalization. Lastly the results indicate that consumers buying non-drinkable yogurts may not be likely to switch to drinkable ones as price changes (and vice versa). This could suggest that the success of drinkable yogurts may be due to an increase in the consumers' base.

As the market for functional foods are in continuous evolution, there are several ways in which this research could be expanded. Two of them are: 1) to use the European Union recent regulation of health claims in food labeling, Regulation (EC) No 1924/2006 20, December 2006 (active in July 2007), as a natural experiment to evaluate the changes in both consumers' and manufacturers' behavior as the new regulation is adopted by the European Country Members; and 2) to model explicitly the strategic long-run investment decision of developing a functional product, inferring on both short-run strategies and long-run profitability.

Endonotes

[1] According to the European Commission's Concerted Action on Functional Food Science in Europe (FuFoSE), coordinated by the International Life Science Institute (ILSI) "*a food product can only be considered functional if together with the basic nutritional impact it has beneficial effects on one or more functions of the human organism thus either improving the general and physical conditions or/and decreasing the risk of the evolution of diseases.*" (Diplock *et al.* 1999). Several others definitions exist: see American Dietetic Association (1999) or Siró *et al.* (2008) for a summary.

[2] Urala and Lätheenmäki (2003; 2004 and 2007) found that among Finnish consumers, the perceived reward and the necessity for functional foods are strong predictors of the willingness to use these products. Verbeke (2005) shows that in the Belgian market believing in the health benefits of functional foods is the main positive determinant of their acceptance. Using samples of MS students living in USA, Canada and France, Labrecque et al. (2006) found that health, health-related benefits' beliefs, and credibility of information are the main positive determinants of the acceptance of these products.

[3] Menrad (2003) reports that Unilever invested more that 50 million US$ to develop the functional yogurt Nestlé Lc1 and the proactive margarine Becel®, sum considerably higher than the general estimated cost of developing a new food product (2 million US$).

[4] Functional food manufacturer have lengthened their product lines associating the new products' brand to the vendor's name or to another well established parent brand, as to use brands' role of guidance or trust typical of markets characterized by high switching costs and large number of alternatives (Rao, Qu and Ruekert 1999). Choi (1998) shows that, by associating the quality of a new product with an established brand name, a multiproduct monopolist can alleviate problems of informational asymmetry leveraging on the reputation of those brands already in the market (*informational leverage*).

[5] The only exception is Maynard and Franklin (2003) who used a combination of willingness to pay survey, sensory evaluation, and feasibility analysis to infer on the potential profitability of "cancer-fighting" dairy products.

[6] As of the November 2009, the EFSA announced its first decisions on 523 (out of 4,159) claims. About 2/3 of decisions were negative; in particular 180 claims for probiotic ingredients were denied, of which 170 could not be assessed because of insufficient information (Starling, 2009).

[7] This situation of uncertainty has not spared large companies that have supported the general thrust of the EU nutrition and health claims legislation: for example Danone (which shared the support that the Yoghurt and Live Fermented Milks Association gave to the legislation) withdrew in April 2009 two article-13.5 submission: a digestive health claim for Activia (spoonable) and one immunity claim for Actimel (drinkable), seeking further guidance from EFSA about scientific requirements. In August 2009, the company submitted an article 14 (disease reduction) claim for Actimel and in November of the same year an article 13.5 health claim to EFSA for Activia; the new dossier includes evidence that the use of Activia could provide digestive health benefits in women.

[8] Each product is identified as a combination of brand (vendor), flavor, fat content and the presence (or absence) of the functional attribute.

[9] In order for the AIDS model to be consistent with the primitive preference structure under which it is derived, the following conditions need to hold: symmetry $b_{jk} = b_{kj}, \forall j, k$, homogeneity and adding-up $\sum_{k=1}^{J} a_j = 1; \sum_{k=1}^{J} \beta_j = 0; \text{and} \sum_{k=1}^{J} b_{kj} = 0$.

[10] Pinkse, Slade and Brett (2002) treat the distance functions as general and the model semi-parametric. Pinkse and Slade (2004) showed that both parametric and semi-parametric specification of the model lead to similar results.

[11] If one opted for using only one discrete measure, the substitution pattern would be restricted to those goods that share a particular neighborhood; using more than one δ_{jk}^{D} additively will reduce the number of 0s in the substitution coefficients. Using both δ_{jk}^{C} and δ_{jk}^{D} will allow instead for a more flexible (and complete) substitution pattern.

[12] Instrumentally to the purposes of this analysis, δ_{jk}^{C} and δ_{jk}^{D} will be used additively, not multiplicatively (as in Pofahl and Richards 2009). A benefit of using an additive form is the ease of interpretation of the estimated parameters.

[13] Pinkse and Slade (2004) proposed the interaction of product characteristics with the own-price, aggregate income and intercept's coefficients, to obtain unique parameters and limit the number of equations to be estimated, with the drawback of increasing the risk of collinearity. In light of this risk and to avoid reducing the flexibility of the model, Pofahl and Richards (2009) estimated the full set of simultaneous equations.

[14] Ronald W. Cotterill, director of the Food Marketing Policy Center and Renato Pieri, director of the Osservatorio Latte are thankfully acknowledged for granting access to the IRI data.

[15] IRI regions are defined consistently with the political boundaries of the Italian regions except "Piedmont and Val d'Aosta", "Basilicata and Calabria" and "Abruzzo and Molise".Trentino Alto Adige was excluded due to the strong presence of regional brands.

[16] The products chosen belong to firms operating nationally with a "reasonably large" (at least 0.5%) expenditure share in the "national" market. The sub-categories are identified by combination of fat content, flavor and "health" content (functional and conventional).

[17] The accuracy of the postings was evaluated by cross-referring available nutritional information by www.ciao.it and manufacturers' websites which, in the cases considered, resulted to be accurate.

[18] For brevity a discussion of cross-price elasticity is omitted. Tables with cross-price elasticities for all the estimated models are available upon request from the authors.

[19] For example, in her robustness checks, Di Giacomo (2008) uses different nesting structures finding that when a more complex nesting structure is assumed (yogurts are nested across three types, children's yogurt, regular yogurts and specialty yogurts), the average values of elasticity increase reaching -3.17, 70% larger than the average values she discusses in the paper.

[20] Pofahl and Richars (2009) found brand-level elasticity in the fruit juice market to vary between -3.15 and -14.18.

Reference

American Dietetic Association. 1999. “Position of the American Dietetic Association - Functional Foods.” *Journal of the American Dietetic Association* 99(8):127-128.

Berger, J., M. Draganska and I. Simonson. 2007. “The Influence of Product Variety on Brand Perception and Choice.” *Marketing Science* 26(4): 460-472.

Betancourt, R.R. 2006. “The Economics of Retailing and Distribution.” Northampton, MA: Edward Elgar Publishing.

Blundell, R. and J.M. Robin, 2000, “Latent Separability: Grouping Goods without Weak Separability,” *Econometrica*, 68, 53–84.

Childs, N.M. and G.H., Poryzees. 1997. “Foods that Help Prevent Disease: Consumer Attitudes and Public Policy Implications.” *Journal of Consumer Marketing* 14:433–447.

Choi, J. P. 1998. “Brand Extension as Informational Leverage.” *Review of Economic Studies* 65:655–669.

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

Di Giacomo, M. 2008. “GMM Estimation of a Structural Demand Model for Yogurt and the Effects of the Introduction of new Brands.” *Empirical Economics* 34:537–565.

Diplock, A. T., Aggett, P. J., Ashwell, M., Bornet, F., Fern, E. B., amd Roberfroid, M. B. (1999). Scientific concepts of functional foods in Europe: Consensus document. *British Journal of Nutrition* 81(supplement 1), S1–S27.

Dhar, T., J.P. Chavas, and B.W. Gould, 2003, “An Empirical Assessment of Endogeneity Issues in Demand Analysis for Differentiated Products,” *American Journal of Agricultural Economics*, 85, 605–617.

Dhar T. , J. P. Chavas, R. W. Cotterill and B. W. Gould 2005. “An Econometric Analysis of Brand-Level Strategic Pricing between Coca-Cola Company and PepsiCo.” *Journal of Economics & Management Strategy*, 14 (4): 905–931.

Draganska, M. and D. C. Jain. 2005. “Product-Line Length as a Competitive Tool” *Journal of Economics & Management Strategy* 14 (1) :1-28(28)

Draganska, M., and D. C. Jain. 2006. “Consumer Preferences and Product-Line Pricing Strategies: An Empirical Analysis.” *Marketing Science* Vol. 25 (2): 164–174.

Gestore Mercato Elettrico Italiano (GME). 2004, 2005. Daily Historical Data on electricity prices and production. Available at www.mercatoelettrico.org. Accessed July 7th, 2008.

Hansen. L. P. 1982. “Large Sample Properties of Generalized Method of Moments Estimators.” *Econometrica* 50:1029–1054.

Herath, D., J. Cranfield, S. Henson, and D. Sparling, D. 2008. “Firm, Market and Regulatory Factors Influencing Innovation and Commercialization in Canada's Functional Food and Nutraceutical Sector.” *Agribusiness: An International Journal* 24 (2):207–230.

Information Resource Inc. (IRI) - Infoscan Database. 2004-2005. Retail Scanner Data on Yogurt Purchases – 17 Italian Regions (Hyper and Super). Milano, Italy.

Istituto Studi dei Mercati Agricoli. 2004, 2005. DATIMA, Prezzi all’Origine del latte vaccino. Available at http//:datima.ismea.it Accessed 07/08/2008.

Kadiyali, V., N. J. Vilcassim and P. K. Chintagunta. 1996. “Empirical Analysis of Competitive Product Line Pricing Decisions: Lead, Follow, or Move Together?” *The Journal of Business* 69 (4): 459-487.

Kim, B. D. and M. W. Sullivan. 1998. “The Effect of Parent Brand Experience on Line Extension Trial and Repeat Purchase.” *Marketing Letters* 9(2): 181–193.

Klemperer, P. 1995. “Competition when Consumers have Switching Costs: An Overview with Applications to Industrial Organization, Macroeconomics, and International Trade.” *The Review of Economic Studies* 62 (4):515-539.

Heasman , M. and J., Mellentin. 2001. “The Functional Foods Revolution: Healthy People, Healthy Profits?” Earthscan Publications Ltd.

Markosyan, A., T. I. Wahl, and J. J. McCluskey. 2007. “Functional Foods in the Marketplace: Willingness to Pay for Apples Enriched with Antioxidants.” Selected paper Presented at the American Agricultural Economics Association Annual Meeting, Portland, OR, July 29-August 1, 2007.

Laure, B., G. E. West, C. Gendron and R. Lambert. 2004. “Consumer Response to Functional Foods Produced by Conventional, Organic, or Genetic Manipulation.” *Agribusiness: An International Journal* 20 (2):155–166.

Labrecque, J.A., M. Doyon, F. Bellavance and J. Kolodinsky. 2007. “Acceptance of Functional Foods: A Comparison of French, American, and French Canadian Consumers.” *Canadian Journal of Agricultural Economics* 54:647–661

The Economist, 2009. The unrepentant chocolatier Oct 29th 2009 | LAUSANNE AND VEVEY | From *The Economist* print edition

Maynard, L. J., and S. T. Franklin. 2003. “Functional Foods as a Value-Added Strategy: The Commercial Potential of “Cancer-Fighting” Dairy Products.” *Review of Agricultural Economics* 25 (2):316-331.

Ministero dello Sviluppo Economico, D. G. E. R. M. Statistiche dell’Energia2004-2006. Available at http://www.sviluppoeconomico.gov.it/ Accessed 07/07/2008.

Moschini, G. 1995. “Units of Measurement and the Stone Index in Demand System Estimation.” *American Journal of Agricultural Economics* 77:63–68.

Nevo, A. 2001. “Measuring Market Power in the Ready-to-Eat Cereal Industry.” *Econometrica* 69:307–342.

Pinkse, J., M. E. Slade and C. Brett. 2002. “Spatial Price Competition: A Semiparametric Approach.” *Econometrica* 70: 1111–1155.

Pinkse, J. and M. E. Slade. 2004. “Mergers, Brand Competition and the Price of the Pint” *European Economic Review* 48: 617–643.

Pofahl, G. M. and T.J. Richards. 2009. “Valuation of New Products in Attribute Space.” *American Journal of Agricultural Economics* 91(2):402-415.

PricewaterhouseCoopers (2009) “Leveraging growth in the emerging functional foods industry: Trends and market opportunities” Available online at http://www.pwc.com/us/en/transaction-services/publications/functional-foods.jhtml Accessed January 22nd 2010.

Rao, A.R., L. Qu, and R. W. Ruekert. 1999. “Signaling Unobservable Product Quality through a Brand Ally” *Journal of Marketing Research* 36 (2):258-268.

Rojas, C. 2008. “Price Competition in U.S. Brewing.” *International Journal of Industrial Organization* 56(1):1-31 .

Rojas, C., and E. B. Peterson. 2008. “Demand for Differentiated Products: Price and Advertising Evidence from the U.S. Beer Market.” *International Journal of Industrial Organization* 48: 617–643.

Schmalensee, R. 1982. “Product Differentiation Advantages of Pioneering Brands Author.” *The American Economic Review* 72(3):349-365.

Siró, I., Kápolna, E., Kápolna, B., & Lugasi, A. (2008). Functional foods. Product development marketing and consumer acceptance, a review. Appetite, 51, 456–467.

Starling, S. (2009) "Life in a European health claims wasteland" Foodnavigator.com – Europe, published Online 09-Nov-2009. Available on-line at http://www.foodnavigator.com/Legislation/Life-in-a-European-health-claims-wasteland Accessed December 10, 2009.

Urala, N., and L. Lähteenmäki. 2003. "Reasons Behind Consumers' Functional Food Choices." *Nutrition and Food Science* 33:148–158.

____________ 2004. "Attitudes Behind Consumers' Willingness to Use Functional Foods." *Food Quality and Preference* 15:793–803.

____________ 2007. Consumers' Changing Attitudes Towards Functional Foods." *Food Quality and Preference* 18: 1–12.

Verbeke, W. 2005. "Consumer Acceptance of Functional Foods: Socio-Demographic, Cognitive and Attitudinal Developments." *Food Quality and Preference*16:45-57.

West, G. E., C. Gendron, B. Larue, and R. Lambert. 2002. "Consumers' Valuation of Functional Properties of Foods: Results from a Canada-wide Survey." *Canadian Journal of Agricultural Economics* 50:541–558.

Weststrate, J. A., G. van Poppel and P. M. Verschuren. 2002. "Functional foods, trends and future." *British Journal of Nutrition* 88(Suppl. 2): S233–S235.

www.ciao.it Repeated access during January 2009.

Table 1. Examples of health claims, products and active components of functional yogurts sold in the Italian market.

Claimed health benefit	Brand/Product	Manufacturer	Active component
Strengthening the intestinal tract and/or the immune system	Actimel	Danone	*Lactobacillus Casei Immunitass*
	LC1 Protection	Nestlé	*Lactobacillus Jonhsonii LA1*
	Kyr	Parmalat	*Lactobacillus Paracasei*
Helping the functional of the intestinal tract	Activia	Danone	*Bifidus Actiregularus*
	Fibresse	Parmalat	*RegoPlus®*
Reducing the absorption of cholesterol	Danacol	Danone	*Phythosterols*
	Yomo Abc Equicol	Granarolo	
Others	Essensis	Danone	*Borage Oil and phytosterols*
	Omega 3 Plus	Parmalat	*Carditop ®*

Source: author's elaboration on IRI Infoscan data; manufacturers' websites.

Note: all the claims refer to a period prior to the implementation of Regulation (EC) No 1924/2006 20, December 2006.

Table 2. Product Characteristics, Average Price and Expenditure Shares by Brand

Brand	*Flavor*	*Type*	*Calories (Kcal)*	*Proteins*	*Carbs*	*Fat*	*Price (€/kg)*	*w*
Conventional								
Danone	Plain	Skim	49	6.1	5	0.1	4.41	1.15
Danone	Plain	Whole	99	3.3	12.5	3.7	4.37	1.35
Danone	Fruit	Skim	52	4.1	7.9	0.1	4.4	12.11
Danone	Others[b]	Skim	58	4.4	8.9	0.1	5.24	2.87
Granarolo	Plain	Skim	39	4.7	4	0.1	3.81	0.84
Granarolo	Plain	Whole	68	3.5	3.5	4	3.5	0.94
Granarolo	Fruit	Skim	75	3.9	13.7	0.1	4.02	1.49
Granarolo	Fruit	Whole	103	3.2	12.5	4.1	4.17	9.15
Granarolo	Others	Whole	117	3.7	15.1	4.3	4.38	3.02
Mueller	Plain	Whole	109	5.1	11.3	4.5	2.91	4.08
Mueller	Fruit	Skim	76	4.6	13.4	0.1	3.94	1.08
Mueller	Fruit	Whole	111	2.9	16.1	3.6	3.37	10.1
Mueller	Others	Whole	118	4.4	15.8	4.4	3.45	2.62
Nestle	Fruit	Skim	40	4.2	5.6	0.1	4.05	1.63
Nestle	Others	Skim	73	4.3	13.4	0.2	4.86	0.57
Parmalat	Fruit	Skim	59	5.2	9.4	0.12	3.47	1.68
Parmalat	Fruit	Whole	109	3.4	15.5	3.7	3.19	6.24
Parmalat	Others	Whole	119.2	3.28	15.36	4.72	3.45	0.85
Functional								
Danone	Plain	Skim	48	4.9	6.1	0.1	4.98	1.07
Danone	Plain	Whole	72	4.2	5.1	3.5	4.96	1.4
Danone	Fruit	Skim	52	4.4	7.5	0.1	5.32	1.08
Danone	Fruit	Whole	104	3.7	13.6	3.4	5.32	3.7
Danone	Others	Whole	103	3.8	13.5	3.3	5.31	7.67
Parmalat	Fruit	Whole	103.2	3.12	14	3.84	4.91	0.77
Parmalat	Others	Whole	106	3.1	14	4.2	5.01	1.02
Functional/drinkable								
Danone	Drinkable	Skim	29	2.7	3.7	0.1	5.55	3.79
Danone	Drinkable	Whole	73	2.7	11.8	1.2	5.54	11
Granarolo	Drinkable	Whole	77	3	12	1.9	5.3	1.2
Nestle	Drinkable	Skim	62	2.7	12.7	0.08	5.29	1.55
Nestle	Drinkable	Whole	77	2.6	14.5	0.9	5.21	3.98

Source: Calories, Proteins, Carbohydrates (Carbs) and Fat content come from nutritional labels collected from various sources. Price and expenditure share (*w*) are author's elaboration on IRI Infoscan data: January 2004 – December 2005 averages.

Note: Product characteristics are measured in g/100g of products. "Others" indicate "other flavors".

Table 3. DM-LAAIDS – Estimated Parameters and related statistics: – price parameters

Variables	Full		Intermediate		Restricted	
Log p_j	-0.0634	**	-0.0521	*	-0.0657	***
	(0.0299)		(0.0320)		(0.0246)	
Log p_j*Fat	-0.0024	***	0.0016	***	0.0020	***
	(0.0003)		(0.0001)		(0.0003)	
Log p_j*Flavor	0.0227		-0.0095		0.0090	***
	(0.0262)		(0.0307)		(0.0025)	
Log p_j*Functional	0.0195	**	0.0199	***	0.0156	***
	(0.0097)		(0.0054)		(0.0038)	
Log p_j*Plain	-0.0203		-0.0222			
	(0.0248)		(0.0306)			
Log p_j*Fruit	0.0396		0.0218			
	(0.0248)		(0.0289)			
Log p_j*Granarolo	-0.0319	***	-0.0104	***	-0.0097	**
	(0.0050)		(0.0004)		(0.0006)	
Log p_j*Parmalat	0.0295	***	-0.0015	***	-0.0037	***
	(0.0037)		(0.0005)		(0.0011)	
Log p_j*Muller	-0.0032		-0.0031	***	-0.0030	***
	(0.0054)		(0.0007)		(0.0012)	
Closeness Carbs/Fat/Prot	0.0017	***	0.0037	***	0.0046	***
	(0.0004)		(0.0005)		(0.0013)	
Closeness Brand	0.0030	***	0.0027	***	0.0028	***
	(0.0001)		(0.0001)		(0.0002)	
Closeness Flavor	-0.0027	***	-0.0109	***	0.0008	**
	(0.0010)		(0.0008)		(0.0004)	
Closeness Functional	0.0018		0.0039	**	0.0021	***
	(0.0014)		(0.0019)		(0.0005)	
Closeness Drink	0.0002		0.0008		-0.0015	***
	(0.0015)		(0.0019)		(0.0003)	

Table 3. DM-LAAIDS – Estimated Parameters and related statistics: price parameters

Variables	Full		Intermediate		Restricted	
Log (x_t/P^{L}_{t})	-0.0024	***	-0.0039	***	-0.0036	***
	(0.0006)		(0.0005)		(0.0004	
Log (x_t/P^{L}_{t})*Prot	5.63E-04	***	5.40E-04	***	5.67E-04	***
	4.21E-05		3.08E-05		3.09E-05	
Log (x_t/P^{L}_{t})*Carbs	3.02E-05		8.21E-06		-1.86E-05	
	6.65E-06		8.18E-06		1.48E-05	
Log (x_t/P^{L}_{t})*Flavor	-0.0035	***				
	(0.0003)					
Log (x_t/P^{L}_{t})*Plain	0.0017	***				
	(0.0001)					
Log (x_t/P^{L}_{t})*Fruit	-0.0050	***				
	(0.0004)					
Log (x_t/P^{L}_{t})*Functional	-0.0009					
	(0.0007)					
Log (x_t/P^{L}_{t})*Parmalat	-0.0031	***				
	(0.0004)					
Log (x_t/P^{L}_{t})*Granarolo	0.0025	***				
	(0.0006)					
Log (x_t/P^{L}_{t})*Muller	-0.0001					
	(0.0006)					
Average Vol. Unit	0.0552	***	0.0574	***	0.0359	***
	(0.0030)		(0.0031)		(0.0112)	
Coverage	0.0083	***	0.0085	***	0.0079	***
	(0.0001)		(0.0001)		(0.0001)	
Constant	0.0120		0.0054		0.0034	
	(0.0248)		(0.0259)		(0.0273)	
R-squared	0.7825		0.7574		0.7470	
Hansen *J*-test [$\chi^{2}_{(5)}$]	9.4806 (*p-val*=0.0914)		9.3478 (*p-val*=0.096)		9.2289 (p-val=0.1003)	
F-test joint significance	F$_{(6,11468)}$ =77.94		F $_{(6,\ 11478)}$=54.94		F $_{(6,\ 11477)}$=12.15	
of instruments	(p-val= 0.0000)		(p-val= 0.0000)		(p-val= 0.0000)	
Mean VIF	48.53		15.19		6.37	

Note: *, **, and *** represent 10, 5 and 1% significance levels. Standard errors in parenthesis

Table 4. Estimated Own-Price Elasticites

Brand	Flavor	Type	Elasticity	*t*-Ratio	Elasticity	*t*-Ratio	Elasticity	*t*-Ratio
Conventional			*Full Model*		*Intermediate*		*Restricted*	
Danone	Plain	Skim	-8.33	-15.85	-7.46	-37.71	-6.72	-3.12
Danone	Plain	Whole	-7.90	-16.68	-6.09	-33.91	-5.35	-2.78
Danone	Fruit	Skim	-1.52	-6.14	-1.43	-5.39	-1.55	-7.55
Danone	Others	Skim	-3.22	-3.08	-3.14	-42.92	-2.98	-3.83
Granarolo	Plain	Skim	-14.79	-43.18	-11.05	-41.62	-9.95	-3.46
Granarolo	Plain	Whole	-14.26	-43.28	-9.26	-36.93	-8.13	-3.02
Granarolo	Fruit	Skim	-7.41	-4.26	-5.18[a]	-2.42	-6.05	-3.72
Granarolo	Fruit	Whole	-2.14	-7.53	-1.60	-4.63	-1.73	-6.25
Granarolo	Others	Whole	-4.45	-5.20	-3.12	-43.02	-2.89	-3.82
Mueller	Plain	Whole	-3.40	-52.16	-2.72	-48.40	-2.47	-3.69
Mueller	Fruit	Skim	-7.13	-3.04	-6.05[a]	-2.09	-7.29	-3.08
Mueller	Fruit	Whole	-1.74	-6.84	-1.48	-4.76	-1.61	-6.05
Mueller	Others	Whole	-3.92	-4.01	-3.18	-39.12	-2.93	-3.12
Nestle	Fruit	Skim	-4.93	-2.67	-4.20[a]	-2.13	-5.05	-3.31
Nestle	Others	Skim	-12.35[a]	-2.32	-11.88	-31.73	-11.01	-2.78
Parmalat	Fruit	Skim	-3.04[b]	-1.86	-4.19[a]	-2.20	-5.14	-3.34
Parmalat	Fruit	Whole	-1.69	-3.77	-1.77	-3.42	-2.01	-4.60
Parmalat	Others	Whole	-6.27[b]	-1.95	-7.45	-29.61	-6.94[a]	-2.40
Functional								
Danone	Plain	Skim	-7.01	-14.15	-6.05	-14.76	-5.66	-2.88
Danone	Plain	Whole	-6.18	-16.61	-4.46	-14.33	-4.07[a]	-2.58
Danone	Fruit	Skim	-5.09	-2.65	-3.97[c]	-1.60	-5.64	-2.88
Danone	Fruit	Whole	-2.40	-4.26	-1.72[b]	-2.38	-2.17	-3.63
Danone	Others	Whole	-1.67	-6.15	-1.47	-25.43	-1.45	-5.65
Parmalat	Fruit	Whole	-4.06[b]	-1.70	-4.56[c]	-1.32	-7.01[a]	-2.31
Parmalat	Others	Whole	-3.40[b]	-1.87	-4.57	-10.22	-4.58[a]	-2.22
Functional/drinkable								
Danone	Drinkable	Skim	-2.16	-3.97	-1.84	-2.62	-2.32	-4.17
Danone	Drinkable	Whole	-1.43	-7.57	-1.27	-5.25	-1.43	-7.37
Granarolo	Drinkable	Whole	-7.68	-5.43	-4.27[b]	-1.93	-5.65	-3.21
Nestle	Drinkable	Skim	-3.87	-2.87	-3.08[b]	-1.77	-4.25	-3.10
Nestle	Drinkable	Whole	-2.16	-4.14	-1.77	-2.63	-2.21	-4.13

Note: “Others” indicates “other flavors”. All values without a superscript are significant at at the 1% level. Superscripts are used to indicate values that are significant at the 5% (a); 10 % (b) level of significance or not significant (c).

Table 5. Estimated Price-Cost Margins and Variation in Profitability

Brand	*Flavor*	*Type*	*Bertrand*	*Portfolio*	$\Delta\%PCM_j^H$
Conventional					
Danone	Plain	Skim	0.15	0.68	–
Danone	Plain	Whole	0.19	0.74	–
Danone	Fruit	Skim	0.65	0.66	–
Danone	Others	Skim	0.34	0.53	–
Granarolo	Plain	Skim	0.10	0.53	–
Granarolo	Plain	Whole	0.12	0.58	–
Granarolo	Fruit	Skim	0.17	0.50	–
Granarolo	Fruit	Whole	0.58	0.59	–
Granarolo	Others	Whole	0.35	0.47	–
Mueller	Plain	Whole	0.20	0.20	–
Mueller	Fruit	Skim	0.09	0.13	–
Mueller	Fruit	Whole	0.41	0.50	–
Mueller	Others	Whole	0.14	0.69	–
Nestle	Fruit	Skim	0.62	0.64	–
Nestle	Others	Skim	0.34	0.56	–
Parmalat	Fruit	Skim	0.19	0.31	–
Parmalat	Fruit	Whole	0.50	0.51	–
Parmalat	Others	Whole	0.14	0.51	–
Functional					
Danone	Plain	Skim	0.18	0.93	20.46
Danone	Plain	Whole	0.25	0.84	21.44
Danone	Fruit	Skim	0.18	0.97	20.45
Danone	Fruit	Whole	0.46	0.63	16.26
Danone	Others	Whole	0.69	0.72	12.31
Parmalat	Fruit	Whole	0.14	0.18	22.45
Parmalat	Others	Whole	0.22	0.23	25.09
Functional/drinkable					
Danone	Drinkable	Skim	0.43	0.54	15.08
Danone	Drinkable	Whole	0.70	0.70	9.00
Granarolo	Drinkable	Whole	0.18	0.18	18.65
Nestle	Drinkable	Skim	0.24	0.33	19.28
Nestle	Drinkable	Whole	0.45	0.46	15.06

Note: “Others” indicates “other flavors”.

Appendix – Comparative statics – variation in product formulation

Under the single-product Nash Bertrand equilibrium assumption, product's *j* margin is determined as $p_j - c_j = -p_j \frac{1}{\eta_{jj}}$. *j* being a functional product, the variation of its profit margin for a change in the functional attribute is:

$$\text{(A1)} \qquad \frac{\partial(p_j - c_j)}{\partial z_j^H} = \frac{\partial p_j}{\partial z_j^H} - \frac{\partial c_j}{\partial z_j^H} = -\frac{\eta_{jj}\frac{\partial p_j}{\partial z_j^H} - p_j \frac{\partial \eta_{jj}}{\partial z_j^H}}{\eta_{jj}{}^2} = -\frac{\partial p_j}{\partial z_j^H}\frac{1}{\eta_{jj}} + \frac{p_j}{\eta_{jj}{}^2}\frac{\partial \eta_{jj}}{\partial z_j^H}.$$

Reorganizing and using the fact that, by definition $-\frac{p_j - c_j}{p_j} = \frac{1}{\eta_{jj}}$, one obtains:

$$\text{(A2)} \qquad \frac{\partial p_j}{\partial z_j^H}\frac{c_j}{p_j} - \frac{\partial c_j}{\partial z_j^H} = -\frac{p_j}{\eta_{jj}{}^2}\frac{\partial \eta_{jj}}{\partial z_j^H},$$

which, manipulating and using (6-a) gives equation (11).

Since, in this scenario, changes in marginal cost will be transferred to price via a proportionality factor defined as $\tilde{b}_j = \eta_{jj} / (1 + \eta_{jj})$ one has $p_j = \tilde{b}_j c_j$. The expression of the contribution of the functional attribute to the price of yogurt *j* is:

$$\text{(A3)} \qquad \frac{\partial p_j}{\partial z_j^H} = \frac{\partial \tilde{b}_j}{\partial z_j^H} c_j + \frac{\partial c_j}{\partial z_j^H}\tilde{b}_j;$$

dividing both sides by p_j and rearranging, it gives:

$$\text{(A4)} \qquad \frac{\partial p_j}{\partial z_j^H}\frac{1}{p_j} - \frac{\partial c_j}{\partial z_j^H}\frac{1}{c_j} = \frac{\partial \tilde{b}_j}{\partial z_j^H}\frac{1}{\tilde{b}_j};$$

indicating that (11) measures the variation in ability to price above cost due to the presence of the functional attribute.