Innovation and brand effects on the consumers' demand for fresh milk in Spain

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Abstract

Innovation represents, nowadays, a key factor for business success but also implies increasing costs associated to continuous new product development. A better understanding of consumer's price responsiveness to food attributes is important for food industries. This study hypothesizes that the more inelastic a specific attribute is and the lower degree of substitutability exists among competing attributes, firms could increase prices with a relatively small impact on the quantities demanded contributing to reduce payback periods. The objective of this study is, then, to calculate attribute price elasticities in order to assess the potential profitability of innovation investments in the Spanish food industry. The milk sector is chosen as a case study as it is one of the most innovative food sectors worldwide. The methodological approach is based on the estimations of an incomplete censored Exact Affine Stone Index (EASI) demand system. Two different demand systems are estimated. The first includes four milk categories: whole, milk, semi-skimmed milk, skimmed milk and enriched milk. In the second, each milk category has been divided into two subcategories taking into account the bran attribute (manufacturer brand and private label. Results indicate that the functional attribute is the most price inelastic indicating that firms could increase the price as the quantity purchased did not vary significantly. However, when we consider brands, this result has to be interpreted with caution as it only refers to the private label enriched milk. Any price increase of the manufacturer brands in the case of the enriched milk generates a substitution effect towards the private label.

Keywords: profitability, innovation, censored demand, EASI, price elasticity, brand effect

Introduction

Innovation has become a major component of competition among companies in the food industry (Grunert et al. 1997) in order to fulfill consumer expectations (Menrad 2004). In fact, in terms of consumer expectations, innovation has become a key element for companies' survival. Innovation allows the food industry to better adapt to a changing environment characterized by increasing world population, increasing urbanization, rising income, new environmental, health and ethical concerns and global changes in population lifestyles which have generated changing eating habits and a growing demand for functional food, processed and ready-to-eat food or convenience food (Weindlmaier 2001). It is very challenging, as many elements such as safety, taste, trust, price, identity, culture and habits have to be taken into consideration, leading to a frequent difficult trade-off balance between innovativeness and precaution where consumer trust plays a key role. Companies that are able to increase the number of successful innovations, as well as to improve the effectiveness of their innovation process, will gain competitiveness (Cooper 1994).

In spite of the important role the agrifood industry plays in the economy, this sector has been usually considered as non-technology intensive or low innovation sector. The empiric evidence indicates that the benefit and the growth of firms depend on its capacity to maintain the innovative activity (Connor, 1981; Galizzi and Venturini, 1996; Geroski et al., 1997).

Studies examining the innovative behavior of the agrofood industry are infrequent. Most of the literature has adopted a supply approach, focusing on factors affecting the innovation activity by firms (Oz Shy, 2000; Entorf and Pohlmeier, 1990; and Narula and Wakelin, 1998; among other). However, results are inconclusive. According to some authors, the decisions to invest in innovation and how much to invest are usually correlated with firm's size (D. Miller, 1983; Fariborz Damanpour, 1992; D. Miller and Peter H. Friesen, 2006): larger firms are more likely to innovate. However, Christensen et al. (1996) demonstrate that this is not always the case, since some of the most profitable firms either do not patent or do not innovate frequently. Other authors have considered that the expenses in innovation facilitate firms the possibility for differentiating their products (Tirole. J, 1992; Chenhall et al., 2001), allowing them to adopt strategies different from those based on price (Teece, 2010; Gatignon and Xuereb, 1997).

As mentioned before, innovation is market oriented; that is, the main objective of innovating firms is to increase market share by satisfying current and new market segments trying to anticipate new demand trends (new ingredients, new attributes, new packaging…). However, the increasing competition among food retailers has generated two mains effects: 1) food prices have stabilized in real terms (increasing consumers' welfare); and 2) new products with new attributes become commodities in a shorter period. The increasing share of private labels in food has contributed significantly to this trend. As a result, innovation represents, nowadays, a key factor for business success but also implies increasing costs associated to continuous new product development. In this context, it seems useful to provide the food industry information about consumers' price responsiveness to different for food attributes.

Our hypothesis is that the more inelastic a specific attribute is and the lower degree of substitutability exists among competing attributes, firms could increase prices with a relatively small impact on the quantities demanded contributing to reduce payback periods. The objective of this study is, then, to calculate attribute price elasticities in order to assess the potential profitability of innovation investments in the Spanish food industry. As consumers take into account different attributes when buying different types of food products, the milk sector is chosen as the case study, taking into account that this is one of the most dynamic food industry subsectors in terms of innovation propensity (Figure 1).

In the milk sector, most of the innovations have been addressed towards three main attributes: health (fat content), functionality (enriched milk with omega-3, calcium, vitamins…) and environment (organic). In relation to fat content, the market is divided in three main categories: whole milk, semi-skimmed milk and skimmed milk, where the second has the higher market share. In relation to the functional attribute, the market is highly fragmented. In this study, all types of enriched milk have been included in a single category. The market share of organic milk is lower than 1%, so we have decided to include also this type of milk in the enriched milk category (they have also similar prices). Additionally, the brand is a key attribute for consumers to make milk choices. Moreover, the milk sector is one of the food sectors in which private labels play a relevant role. Therefore, in order to calculate price elasticities, in this study we have decided to specify two different demand systems: in the first one, brands are not considered, while in the second one milk has been differentiated also taking into account the brand (manufacturer brand vs. private label). Consequently, the first demand system includes four milk categories: whole, milk, semi-skimmed milk, skimmed milk and enriched milk, while in the second eight milk categories have been considered) (each milk category in the first system has been subdivided into two depending on if the milk has been sold under a manufacturer brand or under a private label. In the latter system, we are interested not only on the substitution effect among milk attributes but also among brands.

To calculate price elasticities, the methodological approach used in this paper is based on the estimation of a demand system for milk products. Among the functional forms available in the literature, the Lewbel and Pendakur’s (2009) Incomplete Exact Affine Stone Index (EASI) demand system has been chosen. As they showed, the EASI budget share demand functions are completely linear in parameters making the estimation easier when applied to data including many goods. Second, EASI Engel curves for each good are completely unrestricted and can take arbitrary shapes. The flexibility of these curves has a fundamental impact on price coefficient estimates which facilitates final interpretation. Third, the EASI budget share’s error terms can represent unobserved preference heterogeneity while demographic effects can be easily incorporated into the model.

Most of the literature on food demand has assumed weak separability among food categories and have estimated conditional demand systems for specific subgroups. Although it may be plausible to assume weak separability among food and other expenditure groups, it seems less plausible to impose weak separability among food subcategories, as it does not allow estimating potential welfare changes. Following LaFrance and Hanemann (1989) and Zhen et al. (2014), in this paper we have estimated an incomplete demand system.

The data used in this study refers to household food purchase information provided by the KANTAR WORLDPANEL. The database contains all daily food purchases from a representative and stratified sample of 1146 Catalonian households during 2012 (from January to December). The panel provides rich information about every single act of purchase as well as on socio-demographic characteristics of the participating households. The use of home scan data has gained attention in the literature to analyze the demand for food products since the seminal papers by Jourdan (1981); McLaughlin and Lesser (1986); Capps (1989); Capps and Nayga (1990, 1991a, 1991b) or Nayga and Capps (1991a, 1991b), among others.

To achieve the above-mentioned objective, this paper is structured as follows. Section 2 describes the database used and how it has been managed. Section 3 is addressed to describe the methodological framework, which has to do with the database characteristics. Specifically, we will address questions related to censoring, unit values as proxy of prices, incomplete versus complete demand systems, endogeneity, theoretical restrictions and heteroscedasticity. Section 4 will outline the main results obtained in this study. The paper ends with some concluding remarks.

Data and market description

Homescan microdata from KANTAR WORLDPANEL have been used in this study. The dataset contains information about the daily purchases of a representative and stratified sample of 1146 Catalonian households during 2012. Stratification was done according to several socioeconomic variables. Each household in the panel is provided with a scanning device at home and has to scan all items purchased. For fresh products without UPC code, the household has to describe in a booklet the characteristics of the product bought, the quantity and the price paid.

As mentioned in the introduction, the milk sector has been chosen as a case study. For that reason, we restricted our analysis to only the subset of households that recorded purchases of long conservation (UHT) milk (more than 95% of the milk consumed in Spain is UHT). Although during the year some households exit the database and are substituted by other with similar sociodemographic characteristics, in this study we decided to work only with households reporting food purchases during, at least, 40 weeks. Our final sample was 838 households.

Table 1 shows the main sample characteristics. As can be observed, 94.2% are Spanish while the remaining 5.8% are foreigners. This percentage is lower than the official percentage of immigrants in Catalonia which is around 14% according to the figures provided by the Catalan Institute of Statistics IDESCAT. The reason is that the percentage of households exiting the sample is higher among immigrants. In relation to the age of the head of the household, our sample underestimates the younger segment due to the same reasons that that mentioned above. The rest of the sample characteristics are very similar to those from the general population in Catalonia.

The dataset contains information for more than 500 UHT milk references, which are characterized by: 1) Brand; 2) Variety/taste (natural, lactose free and more than 29 additives), 3) Fat content (whole, semi skimmed and skimmed milk); 4) production system (conventional and organic, although the share of organic milk hardly arrives at 0,5%); 5) packaging material (plastic and tetra pack; 6) Package size (0.33l, 0.5l., 1l, 1.2 l, and 1.5l). All references have been grouped taking into account two attributes: 1) the type of milk, with four levels (whole, semi skimmed, skimmed and enriched milk (including organic); and 2) brand (manufacturer and private), giving a total of eight UHT milk categories.

Purchased quantities (in liters) and expenditures in each milk category have been aggregated to the annual level for each household. Unit values per liter have been obtained by dividing expenditures by the purchasing quantities. For the purposes of this study, two different databases have been defined depending on the number of attributes considered. The first one only considers the type of milk (four categories) while the second includes the full eight categories mentioned above.

Although some type of milk is present in almost all households during the year, the situation is somewhat different when we consider specific UHT milk categories. Table 2 shows the percentage of households buying the different milk categories in the two datasets. The semi skimmed milk is the most popular UHT milk with around 70% of the households consuming, followed by whole milk (53.0%) and enriched milk (48.2%). If the brand is considered in the analysis, percentages decrease. It is worth noting that 50% of the Catalonian households consume private label semi skimmed milk.

Table 3 shows the relative importance of the private label in the Catalonian UHT milk market. As can be observed the market share is 60% of the total UHT milk market being Hacendado (from the retailer Mercadona) the leader private label, accounting for 37.7% of the total sales among private-labeled products. In relation to the different types of UHT milk consumed in Catalonian households, Table 3 also shows the market share of each category in Catalonia. Consistent with Table 2, the most consumed milk category is the semi skimmed milk with approximately 40% of the total milk consumption, followed by the whole milk which represents 24.6% of the total milk consumption, the skimmed milk (22%) and the enriched milk (18.1%).

Among the household socio-demographic characteristics, the social class and the family size have been proved to show significant differences in UHT milk consumption in Catalonia. Table 3 shows the market share of manufacturer and private brands in Catalonia taking into account the social class and the household size. In relation to social classes, private labels dominate always the market. However, we observe that the higher the social class is the higher is also the market share of the manufacturer brand. Moreover, in all segments, the semi-skimmed milk seems to be the most preferred milk and the ranking of the different types of UHT milk across segments is identical. The only significant difference is that in the upper social class we appreciate a substitution between semi-skimmed milk and enriched milk.

The bottom of table 3 shows the market share of the different types of UHT milk taking into account the household size. Although the private label dominates the market, we can observe that the relative importance of the manufacturer brand increases as the family size decreases. Finally, the semi-skimmed milk seems to be the most preferred UHT milk independently of the household size, although it is worth mentioning that in larger households the market share of the enriched milk decreases.

Methodological framework and empirical estimation

The EASI demand system

Price elasticities have been calculated from estimating an Incomplete Exact Affine Stone Index (EASI) demand system (Lewbel and Pendakur, 2009). The EASI cost function is given by:

$$\ln C(p,y,z,\varepsilon) = y + \sum_{j=1}^{J} m^j(y,z)\ln p^j + \frac{1}{2}\sum_{j=1}^{J}\sum_{k=1}^{J} a^{jk}(z)\ln p^j \ln p^k + \frac{1}{2}\sum_{j=1}^{J}\sum_{k=1}^{J} b^{jk}\ln p^j \ln p^k y + \sum_{j=1}^{J}\varepsilon_j \ln p^j \quad (1)$$

where y is the implicit utility function and corresponds to an affine function of the Stone index deflated by the log of the nominal expenditure, P is the price vector, z is a vector of demographic variables which proxy observable preference heterogeneity and ε a vector of error terms which include unobservable heterogeneity of preferences.

The EASI budget share demand equations are given by:

$$W_{gh} = \sum_{r=0}^{L} b_{rg}\, y_h^r + \sum_{m=1}^{M}\left(C_{mg}Z_{mh} + D_{mg}Z_{mh}Y_h\right) + \sum_{i=1}^{N} A_{ig}\log p_{ih} + \sum_{i=1}^{N} B_{ig}\log p_{ih}\, y_h + \varepsilon_{gh} \quad (2)$$

where sub-indices g and h correspond to the g-th category of good i and to the h-th household, respectively; y_h is the total household real expenditure (y_h = ln x_h +$\sum_{i=1}^{N} w_{ih}\log p_i$), being x_h the total nominal expenditure; N is the number of goods; p_i is the price of the i-th good, W_{gh} corresponds to the budget share of the g-th food category in the h-th household; M is the number of households; Z_{mh} is a vector of household demographic characteristics, C_{mi} , D_{mi} , A_{ki} , B_{ki}, and b_i are parameters to be estimated and ε_{ih} is an random error term with unknown distribution. L is the highest order of the polynomial in y_h which makes Engel curves to be flexible and which will determined empirically.

Equation (2) is a reduced form of Lewbel and Pendakur's (2009) original demand equations as we have omitted the interaction terms between socio-demographic characteristics and prices to reduce the number of parameters to estimate. Moreover, as noted in the definition of y_h the system (2) corresponds to the linear approximate EASI demand system since Lewbel and

Pendakur (2009) found that the linear approximate EASI and full nonlinear EASI models generate extremely close parameter estimates.

In (2) theoretical restrictions are given by:

- Adding up: $\sum_{g=1}^{N} b_{0g}$ = 1 for r = 0, $\sum_{g=0}^{N} b_{rg}$ = 0 for r ≠ 0
- Homogeneity: $\sum_{g=1}^{N} A_{ig}$ = $\sum_{g=1}^{N} C_{mi}$ = $\sum_{g=1}^{N} D_{mi}$ = $\sum_{g=1}^{N} B_{mi}$ = 0 ∀ g
- Symmetry: Concerning the symmetry of the Slutsky matrix, it is satisfied by symmetry of the n x n matrices A and B which are composed of parameters A_{ig} and B_{ig}.
- Negativity: The Slutsky function is negative

Despite its advantages, in the EASI demand system the derivatives of the budget shares with respect to income and log prices provide the so called Marshallian demand semi-elasticities. In any case, from such expressions, the Hicksian and Marshallian price elasticities can be calculated by using the following expressions (Lewbel and Pendakur, 2009) calculated at the sample means:

- Hicksian price elasticities of good g with respect to price i

$$E_{gi}^{*} = \frac{1}{w_g}\left(A_{ig} + B_{ig}y_h\right) + w_i - \delta_{gi} \tag{3}$$

where δ is the kronecker delta, which is equal to 1 when g = i, and equals zero, otherwise.

- Marshallian price elasticities of good g with respect to price i.

$$E_{gi} = E_{gi}^{*} + w_i \gamma_g \tag{4}$$

- Expeditare elasticities

$$\gamma_g = \frac{1}{w_g}\left(1 - \sum_{i=1}^{N} w_i \, logp_i\left(\gamma_g - 1\right)\right)\left(\sum_{r=1}^{L} r\, b_{rg} y_h^{r-1} + \sum_{m=1}^{M} D_{mg} Z_{mh} + \sum_{i=1}^{N} A_{ig} \log p_i\right) + 1 \tag{5}$$

where γ_g is the expenditure elasticity of commodity group g with respect to nominal expenditure x_h.

- Marginal effects of socio-demographic variables on expenditure shares can be calculated by:

$$\frac{dw_g}{dz_m} = C_{mg} + D_{mg} y_h$$

while the marginal effect on nominal expenditure is given by: $x_h \frac{dw_g}{dz_m}$

The empirical model

Taking into account the characteristics of our dataset, some assumptions have been made to specify and estimate the empirical model. Particularly, we will focus on the following questions: 1) unit values as proxy of prices; 2) the specification of complete vs. incomplete demand system; 3) the zero purchases issue; 4) the endogeneity of prices and expenditure; and 5) the potential heteroscedasticity problem.

Quality-adjusted unit values

As mentioned in section 2, unit values have been calculated by dividing household aggregated annual expenditures of different UHT milk categories by aggregated annual quantities. As it is well known in the literature, taking unit values as proxies for market prices could lead to biased parameter estimates. To solve this problem, we have followed Cox and Wohlgenant (1986) to calculate the so-called quality-adjusted unit values by regressing the unit values(UV_{ig}^{h}) on the following instruments: the log of the food-at-home expenditure (ln(x)), the log of quantities (ln (q)), income classes and variables explaining households' durable ownership. These latter variables will not be included in the EASI demand system specification:

$$\ln UV_{ig}^{h} = \sum_{m=1}^{M} \beta_{igm} Z_m^* + \gamma_{ig} \ln q_{ig}^{h} \quad + \alpha_{ig} \ln x_h + \epsilon_i \qquad (6)$$

where Z_m^* stands for the socio-demographic variables of household h, q_{ig}^{h} is the quantity of the aggregated milk product i within the category g purchased by household h, x_h is the total food expenditure of household h, β, α and γ are the unit value equation parameters to be estimated, and ϵ_i is the residual. The adjusted unit values from this equation (6) are used as proxy for prices ($\log p_{ih}$) into the EASI demand system.

Incomplete demand system

Most of the literature on the food demand has assumed weak separability among food categories and have estimated conditional demand systems for specific subgroups. If the interest is on simulated the effect of some price changes (as it is our case), estimating a conditional demand system does not allow to correctly estimate welfare changes (LaFrance and Hanemann, 1989; and Zhen *et al.*, 2014). They suggest estimating an incomplete demand system. Moreover, it is plausible to assume weak separability among food and other expenditure groups but it seems less plausible to impose weak separability among food subcategories.

In this context, in this study we have estimated an incomplete demand system in order to calculate total food expenditure elasticities. The main drawback is that we have to define the price of a “composite numéraire” good that represents all goods not individually modeled in the system. To construct the price of this composite good, first we have aggregated all food products included in our data set in 54 subgroups. Second, we have followed the same procedure that we used for milk categories in order to define the price for each of the food products included in the dataset. Third, unit values were used to calculate a Fisher composite price index representing each of the 54 food subgroups. The Fisher price index is considered the most appropriate as it is a geometric mean of the Laspeyres and Paasche price indices. Moreover, it satisfies all of the 20 Diewert‘s axiomatic tests of index numbers and is deemed “superlative” for its ability to “approximate homothetic preferences” (Diewert 1998). The Fisher price index for household *h and* food subgroup g is defined by:

$$P_{fg}^{h} = \sqrt{P_{Pg}^{h} \; P_{Lg}^{h}} \tag{7}$$

where P_{Pg}^{h} and P_{Lg}^{h} are the h-th-household Laspeyres and Paasche price indices for the g-th food category, respectively, calculated as:

$$P_{Lg}^{h} = \frac{\sum UV_{ig}^{h} q_{ig}}{\sum UV_{ig} q_{ig}} \qquad\qquad P_{Pg}^{h} = \frac{\sum UV_{ig}^{h} q_{ig}^{h}}{\sum UV_{ig} q_{ig}^{h}} \tag{8}$$

where UV_{ig}^{h} is the unit value for the i-th aggregated food product within the subgroup g for household h, UV_{ig} is the unit value for the i-th aggregated food product within the subgroup g for the average household and $q_{ig}$is the average quantity purchased of the i-th aggregated food product within the subgroup g for the average household.

Censoring

As shown in Table 2, in this study the presence of zero purchases is an important issue. To tackle with it, we have followed the approach suggested by Shonkwiler and Yen (1999), which has been widely used in similar studies. The censored demand system is represented by the following equation, in which the censoring of each milk category is governed by the stochastic process

$$W_{g}^{h*} = f\left(y^{h} z^{h} P^{h}; \theta_{g}\right) + e_{g}^{h} \qquad d_{g}^{h*} = \alpha_{g}^{h} x^{h} + \vartheta_{g}^{h} \tag{9}$$

Where $d_{g}^{h} = \begin{cases} 1 \text{ if } d_{g}^{h*} > 0 \\ 0 \text{ if } d_{g}^{h*} \leq 0 \end{cases}$ and $W_{g}^{h} = d_{g}^{h} * W_{g}^{h*}$

In this system g refers to commodity group and h to household. The variable W_{g}^{h*} is the latent (unobserved) budget share and d_{g}^{h*} is the latent variable defining the sample selection which represents the discrete choice decision of a household whether to buy or not a commodity. The function $f(y^h z^h P^h; \theta_g)$ is the EASI model as in the equation (2).

The demand system (9) is estimated using a two-step process. First, a multivariate probit model describing the sample selection is estimated assuming that the household decision to purchase a particular milk category is not independent of the decision to purchase another category (i.e. there is a substitution effect). Table 4 shows the explanatory variables used in the multivariate probit system. The estimated parameters of α_g^h are used to calculate the standard normal cumulative distribution function $\Phi(\hat{\alpha}_g^h x^h)$ and the probability density function $\phi(\hat{\alpha}_g^h x^h)$. In the second step, the two above-mentioned functions were incorporated into the EASI demand system as follows:

$$W_{gh} = \Phi(\hat{\alpha}_g^h x^h) f \sum_{r=0}^{L} b_{rg} y_h^r + \sum_{m=1}^{M} (C_{mg} Z_{mh} + D_{mg} Z_{mh} Y_h) + \sum_{i=1}^{N} A_{ig} \log p_{ih} + \sum_{i=1}^{N} B_{ig} \log p_{ih} \, y_h) + \delta_g \phi(\hat{\alpha}_g^h x^h) + \mu_g \qquad (10)$$

The expressions (3) to (5) to calculate demand elasticities are modified accordingly to account for censoring in the following way:

- Hicksian price elasticities:

$$E_{gi}^{*} = \frac{1}{w_g} \widehat{\Phi_g} (A_{ig} + B_{ig}) + w_i - \delta_{gi} \qquad (11)$$

- Expenditure elasticities:

$$\gamma_g = \frac{1}{w_g} \Phi(1 - \sum_{i=1}^{N} w_i \, log p_i (e_{gx} - 1))((\sum_{r=0}^{L} r \, b_{rg} y_h^{r-1} + \sum_{m=1}^{M} D_{mi} Z_{mh} + \sum_{i=1}^{N} A_{ig} \log p_{ih}) + 1 \qquad (12)$$

where e_{gx} is the expenditure elasticity of commodity group g with respect to nominal expenditure x.

Endogeneity of income and prices

As we mentioned before, the total real expenditure (y_h = ln x_h +$\sum_{i=1}^{N} w_{ih} \log p_i$) is a function of the dependent variables (shares) generating an endogeneity problem. Moreover, traditional instrumental variable techniques are inconsistent when applied to non-linear models such as the EASI model. As a solution, a two stage residual inclusion (2SRI) procedure is employed as suggested by Blundell and Robin (2000).

The first stage of the procedure involves regressing the log of expenditures on socio-demographic characteristics (Z_{mh}), log prices ($\log p_{kh}$), log household income and interactions between the socio-demographic characteristics, prices and the log of income. In the second stage, residuals from the auxiliary regression are used as an additional regressor in the demand model (10).

Heteroscedasticity

The two-step process generates heteroscedastic errors in (10). To account for this issue we have used the non-parametric bootstrapping procedure by Wooldridge (2002) to estimate the parameter, elasticities and marginal effects standard errors. The bootstrapping procedure takes a sample with replacement from the dataset used to estimate the model originally and calculates the parameters of the demand model and resulting elasticities using this sample.

Results and discussion

The methodological framework described above has been used to calculate price elasticities for UHT milk attributes. If a specific attribute is price inelastic and there are no close substitutes, firms could increase the consumer price for UHT milks including such attribute to reduce innovation payback periods. As mentioned above, two different datasets have been considered being the main difference the inclusion or not of the brand (private or manufacturer). We anticipate that conclusions are rather different using the two datasets.

Without considering the brand attribute

In this case, the demand system includes 4 milk categories (whole milk; semi-skimmed milk; skimmed milk and enriched milk) plus the composite numeraire calculated as in (7). Quality-adjusted prices have been estimated by regressing unit values on the log of the total food-at-home expenditure, the log of the quantity purchased, the social class, the nationality of the head of the household and the presence of pets at the household. Quality adjusted prices have been introduced in the censored demand system. To determine the proper degree of the expenditure polynomial we have estimated alternative models and have tested the joint significance of parameters b_{rg}. In our case a third order polynomial fitted better the data. From the estimated parameters[1], expenditure and price elasticities have been calculated.

Expenditure elasticities of the four milk categories are presented in Table 5. As can be observed, all expenditure elasticities are positive and statistically significant; this means that the consumption of milk in Spain increases with expenditure (all milk categories behave as necessities). For the whole milk, a one percent increase in the household expenditure for food at home would increase the consumption of whole milk by 0.82%. This expenditure elasticity is higher than those for the lower fat content milk types (0.69% and 0.72% for the semi-skimmed

[1] Estimated parameters are not included due to space limitations but are available from authors upon request

and skimmed milk, respectively). Finally, results indicate that the highest expenditure corresponds to the enriched milk which could be explained by its relative higher price.

Table 6 shows presents the results of the estimated Marshallian own-price and Hicksian cross price elasticities. All demands are inelastic. In other words, price changes only generate a moderate effect in the demand for any type of milk. It is also interesting to note that among the four milk categories, the enriched milk shows the more inelastic demand (-0.40). Any change in the price of the enriched milk has a very low effect on quantity demanded. As mentioned in the introduction, this would suggest that dairy firms could increase marketing margins via prices, with a very low impact on the demand for such type of milk. The sufficient condition is that the cross-price elasticities are negative or not significant. This is the case in our study. As can be observed in Table 6, most of the cross-price elasticities related to the enriched milk are negative and, in almost of the cases, significant, indicating complementarity relationships between the enriched milk and the other types of milk. Both results mentioned above suggest that investments in enriched milk are worth as dairy firms can apply a price premium to speed the return on investment (own price elasticity is low and there are no close substitutes)

The rest of cross-price elasticities are also consistent with a priori expectations. Whole milk and semi skimmed milk are close substitutes, suggesting that households will shift a portion of their consumption from whole milk to semi skimmed milk when the price of the whole milk increases. This result is interesting as what we observe in the market is that each brand fixes the same price for the different fat content milks. The other interesting substitution effect is between semi-skimmed and skimmed milk. Households would increase the skimmed milk consumption by 2.39% when the price of semi skimmed milk increases by 10%. On the other hand, the whole milk and the skimmed milk are complementary products (if the price of the whole milk increases by 10%, the skimmed milk consumption decreases by 1.6%). This relationship is not symmetric, in fact, when the price of the skimmed milk rises by 10%, the consumption of the whole milk decreases by 0.8%.

Table 7 shows the marginal effects of sociodemographic characteristics used in the model (presence of children and age of the head of the household). Results indicate that as the age of the head of the household increases the consumption of the skimmed and enriched milk while that of the whole and semi-skimmed mild decreases. In any case the marginal effect is not significant. The presence of children increases the consumption of whole milk while the consumption of skimmed milk decreases. The effect on the other types of milk is not significant.

Considering the brand attribute

When considering the brand attribute, the demand system includes 8 types of UHT milk (whole milk - manufacturer brand; whole milk - private label; semi-skimmed milk - manufacturer brand; semi-skimmed milk - private label; skimmed milk - manufacturer brand; skimmed milk - private label; enriched milk - manufacturer brand; and enriched milk - private label) plus the composite numeraire. The estimation procedure has been exactly the same than in the previous case.

From the estimated parameters of the incomplete censored demand system[2], expenditure and price elasticities as well as marginal effects for sociodemographic characteristics have been calculated. Table 8 shows the expenditure elasticities of the eight milk categories. As in the previous case, the expenditure elasticities are higher in the case of the enriched milk. The second overall result is that in all cases expenditure elasticities for manufacturer brands are higher than for private labels. Differences are smaller in the case of the enriched milk and increase by around 10% in the case of the other types of milk. The main difference in relation to the demand system without brands is that the expenditure elasticity for semi-skimmed milk is now higher than those for whole and skimmed milk. In any case, results are quite consistent with the budget shares of the different types of milk.

Table 9 shows the Marshallian own price and Hicksian cross price elasticities. As can be observed, all uncompensated own-price elasticities are negative and lower than unity. Results are quite consistent with those obtained in the demand system without brands. The enriched milk, both in the cases of manufacturer brand and private label, are fairly price inelastic (i.e.: a price change of 10% only affects the quantity purchased by 24% and 17% for the manufacturer brand and the private label, respectively).

Another global result to note is that for each type of milk, the demand for the manufacturer brand is more price elastic than the demand for the private label. This is consistent with the a priori expectations. If the price of the manufacturer brand increases, there can be a substitution effect to the private label. But if the price of the private label increases in relation to the manufacturer brand, the substitution among the two brands is more limited as the private label will keep being cheaper. This is particularly relevant in the case of the enriched milk. As can be observed, in Table 9, the cross price elasticity between the manufacturer brand and the private label (0.09) is positive and significant, while the cross price elasticity between the private label and the manufacturer brand (0.11) is not significant. In other words, there exists a substitution effect between the manufacturer brand enriched milk and the private label enriched milk (i.e. households will shift a portion of their consumption from manufacturer brand enriched milk to private label enriched milk when the price of the manufacturer brand increases). Something similar happened in the whole and semi-skimmed milk (in the latter case, both cross price elasticities are not significant).

In the demand system without brands we arrived at the conclusion that any innovation in the enriched milk sector could be compensated with increasing prices to compensate costs as this product was fairly price inelastic with no close substitutes. However, when we consider brands, this result only holds for the private label milk. In the case of the manufacturer brand, price

[2] Results are not included due to space limitations but are available from authors upon request.

increases can lead to a substitution not only to private label enriched milk but also to semi-skimmed or skimmed manufacturer brands.

We observe also a substitution between the health (low fat) and the functional attributes. In fact, if the price of the manufacturer brand skimmed milk increases, there is a significant substitution effect towards the branded enriched milk (the cross elasticity is 0.97, the highest value among cross price elasticities). This substitution effect is lower in the case of the semi-skimmed milk (the cross price elasticity between the manufacturer brand skimmed milk and both the manufacturer brand and private label semi-skimmed milk are 0.26 and 0.14, respectively). On the other hand, in the case of the semi-skimmed milk, we have found a significant substitution effect with the manufacturer brand skimmed milk (0.31) and the private label enriched milk (0.17).

In general terms, manufacturer brands have closer substitutes than private labels. The only exception is the private label semi-skimmed milk with significant positive cross price elasticities with manufacturer brands in all types of milk.

Finally, we have found also some interesting complementary relationships. The most noticeably is that the private label skimmed milk is a compliment of almost all types of milk. Additionally, it is worth mentioning the relationship between manufacturer brand whole milk with manufacturer brand semi-skimmed milk (-0.06); the private label whole milk with any type of enriched milk and the private label enriched milk with the rest of private label milks.

Results from marginal effects of sociodemographic variables are presented Table 10. The introduction of brands allows us to clarify some of the results found in the demand system without brands. In relation to the presence of children, results are quite consistent with those of Table 6 but more specific. It is true that the presence of children increases the consumption of whole milk, but only in the case of the manufacturer brand, and decreases the consumption of skimmed milk, but only is significant in the case of the private label.

In relation to the age of the head of the household, we have found here more significant marginal effects. In fact, elder population increases the consumption of skimmed milk (both sold under a manufacturer brand or a private label). On the other hand, the consumption of whole milk (only in the case of manufacturer brand) and semi-skimmed milk (only in the case of a private label) decreases. The effect on any type of enriched milk is also positive, but not significant.

Concluding remarks

The foremost aim of our study has been to calculate attribute price elasticities in order to evaluate the potential profitability of innovation investments in the milk sector since it has been considered one of the most innovative subsectors within the food industry in Spain. Our hypothesis has been that the innovation on a specific attribute of a food product is more profitable if the demand for such specific attribute is almost perfectly inelastic and there appears not to be close substitutes. In this context, firms can increase prices with no significant effect on the quantity purchased, thus reducing the return on investment period. However, if brand effects are not taking into account, results can be misleading.

To calculate the price and expenditure elasticities microdata from the Kantar Homescan dataset have been used. Taking into account the specific characteristics of the dataset the methodological framework has been based on the estimation of a censored incomplete Exact Affine Stone Index (EASI) demand system in which issues unit values and endogeneity of prices and expenditure have been explicitly considered. To analyze the impact of brands, two data sets have been used. The first one only considers the most relevant UHT milk consumed in Spain (whole, semi-skimmed, skimmed and enriched), while the second duplicates the number of categories by considering the brand (manufacturer or private).

Results from the estimation of the two demand systems suggest a number of points. Regarding the expenditure elasticities, all are positive and lower than unity, indicating that fresh milk categories can be considered as necessities. In both models, the expenditure elasticity of the enriched milk is the highest. When we differentiate by brands, the expenditure elasticity of the manufacturer brand is higher than that of the private label for each milk category.

Concerning the own price elasticities of milk categories, both models have provided consistent and statistically significant results. The demand for all milk categories are price inelastic. Results also show that the functional attribute is the most price inelastic indicating that firms could increase prices as the quantity purchased did not vary significantly and firms could get returns on investments in a shorter period. However, when we consider brands, this result has to be interpreted with caution as it only refers to the private label enriched milk. Any price increase of the manufacturer brands in the case of the enriched milk generates at the consumer level a substitution effect towards the private label. This is an interesting result as most of previous studies that have considered the demand for attributes have focused on intrinsic attributes related to the food product only but they have not considered the brand effect. The explicit consideration of brand suggests different results.

Results from this study also suggest that there exists a substitution effect between the fat content attribute and the functional attribute. However, in the case of the whole milk most of the cross price elasticities indicate complementary relationships. When the brands are considered, it is important to note that the manufacturer brand is always more price inelastic that its private label counterpart. Finally, the substitution effect between low fat and functionality is more evident in the case of skimmed milk. Price increases of manufacturer brand skimmed mild generate an increasing consumption of private label enriched milk.

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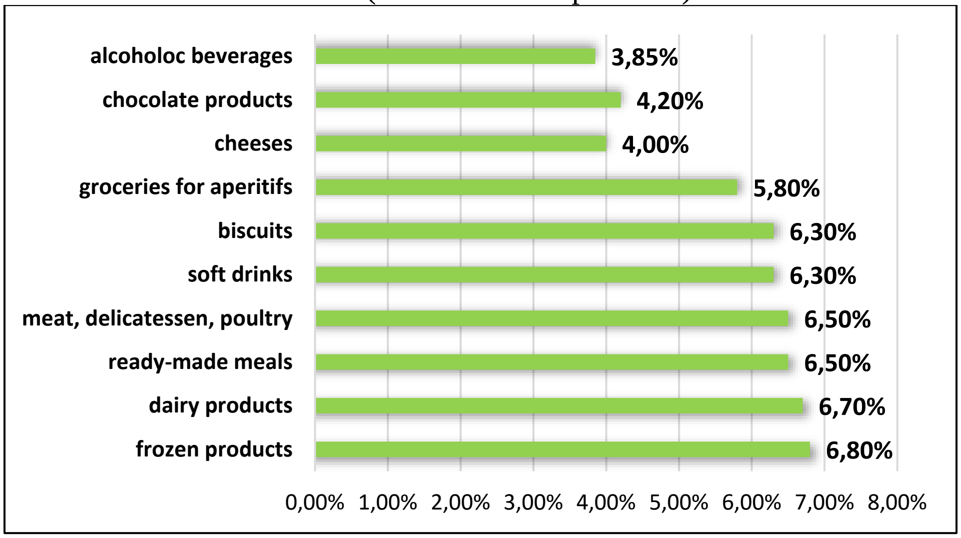
Figure 1. Top 10 most innovative food sectors in terms of new products introduced into the market (% of total new products)



Source: Food Drink Europe Data & Trends, 2013-2014

Table 1. Socio- demographic characteristics of the sample

Nationality	
Spanish	**94.2%**
Others	**5.8%**
Life cycle	
Independent adults	3.2%
Single-parent households	9.5%
Independent youth	1.2%
Adult couples without children	15.1%
Households with children in middle age	21.4%
Households with older children	17.1%
Households with young children	15.4%
Young couple without children	5.3%
Retirees	11.8%
Social class	
Upper + Upper-middle	20%
Middle	36%
Lower Middle	23%
Lower	21%
Age of the head of the household	
Less than 35	7.2%
From 35 to 49	43.7%
From 50 to 64	33.4%
More than 64	15.8%
Household members (average, standard deviation)	3.10 (1.093)
Households with children	38.6%
Household without children	61.4%

Source: Own elaboration from KANTAR Homescan database

Table 2. Percentage of Catalonian households consuming the different types of UHT milk

Without considering brand	
whole milk	53.0%
Semi skimmed milk	69.5%
Skimmed milk	43.7%
Enriched milk	48.2%
Considering brand	
Manufacturer whole milk	36.2%
Private label whole milk	35.3%
Manufacturer Semi skimmed milk	44.7%
Private label Semi skimmed milk	50.7%
Manufacturer Skimmed milk	24.6%
Private label Skimmed milk	31.9%
Manufacturer Enriched milk	26.3%
Private label Enriched milk	32.5%

Source: Own elaboration from KANTAR Homescan database

Table 2. Market share of manufacturer and private brands in the milk market in Catalonia by social class and family size

	Total	Upper and upper middle class	Middle class	Lower middle class	Lower class
Manufacturer Brand	40.1%	48.2%	39%	35%	39.3%
Private label	59.8%	51.8%	61%	65%	60.7%
Whole	24.6%	24.3%	24%	26%	23.8%
Semi-skimmed	35.1%	32.4%	36.6%	35%	35.2%
Skimmed	22%	22.5%	21.6%	22.1%	22.1%
Enriched	18.1%	20.5%	18%	15.6%	18.8%
	Household Size (members)				
	1	2	3	4	>5
Manufacturer Brand	44.7%	45.4%	42.8%	33.6	39.4%
Private label	55.3%	54.5%	57.1%	66.3%	60.53%
whole	21%	18%	24.8%	26.2%	31%
Semi-skimmed	37%	36.8%	37.6%	30.9%	36.1%
Skimmed	21.3%	23.9%	17.9%	23.6%	21.3%
enriched	19.4%	21.1%	19.35%	19.1%	11.3%

Source: Own elaboration from KANTAR Homescan database

Table 4. Explanatory variables used in the estimation of multivariate probit models

Life cycle	Independent adults	Dummy variable that takes the value 1 if the head of the household is an independent adult, and 0 otherwise
	Single-parent households	Dummy variable that takes the value 1 if the head of the household is a single parent, and 0 otherwise
	Independent youth	Dummy variable that takes the value 1 if the head of the household is an independent young person, and 0 otherwise
	Adult couples without children	Dummy variable that takes the value 1 if the household is formed by a couple without children , and 0 otherwise
	Households with middle age children	Dummy variable that takes the value 1 if the household has children in middle age, and 0 otherwise
	Households with older children	Dummy variable that takes the value 1 if the household has older children, and 0 otherwise
	Households with young children	Dummy variable that takes the value 1 if the household has young children, and 0 otherwise
	Young couple without children	Dummy variable that takes the value 1 if the household is made by a young couple without children, and 0 otherwise
	Retirees	Dummy variable that takes the value 1 if the households is made by retirees, and 0 otherwise
Social class	Higher + M higher	Dummy variable that takes the value 1 if the head of the household belongs to higher-middle higher social class and 0 otherwise.
	Middle	Dummy variable that takes the value 1 if the head of the household belongs to middle social class and 0 otherwise.
	M Lower	Dummy variable that takes the value 1 if the head of the household belongs to middle Lower social class and 0 otherwise.
	Lower	Dummy variable that takes the value 1 if the head of the household belongs to middle Lower social class and 0 otherwise.
Age	Less than 35	Dummy variable that takes the value 1 if the head of the household is younger than 35 years old and 0 otherwise.
	From 35 - 49	Dummy variable that takes the value 1 if head of the household is between 35 and 49 years old and 0 otherwise.
	From 50 to 64	Dummy variable that takes the value 1 if the head of the household is between 50 and 64 years old and 0 otherwise.
	More than 64	Dummy variable that takes the value 1 if the head of the household is more than 64 years old and 0 otherwise.
Household size	One member	Dummy variable that takes the value 1 if the household includes only one member and 0 otherwise.
	Two members	Dummy variable that takes the value 1 if the household includes two members and 0 otherwise
	Three members	Dummy variable that takes the value 1 if the household includes three members and 0 otherwise
	Four members	Dummy variable that takes the value 1 if the household includes four members and 0 otherwise
	Five or more members	Dummy variable that takes the value 1 if the household includes five or more members and 0 otherwise
Body Mass Index	Underweight	Dummy variable that takes the value 1 if the head of the household has a Body Mass Index under 20 and 0 otherwise.
	Normal	Dummy variable that takes the value 1 if the head of the household has a BMI between 20 and 25and 0 otherwise.
	Obese	Dummy variable that takes the value 1 if the head of the household has a BMI over 30 and 0 otherwise.
	Overweight	Dummy variable that takes the value 1 if the head of the household has a BMI between 25 and 30 and 0 otherwise.

Table 5. Expenditure elasticities of UHT milk categories (without brands)

	Whole milk	Semi skimmed milk	Skimmed milk	Enriched milk
Expenditure elasticity	0.82*	0.69*	0.72*	0.91*
	(0.005)	(0.035)	(0.027)	(0.017)

Note: Standard errors in parentheses

* Denotes significance at the 10% level of significance.

Table 6. Estimated Marshallian own price and hicksian cross price elasticities of UHT milk categories (without brands)

	Whole milk	**Semi skimmed milk**	**Skimmed milk**	**Enriched milk**
Whole milk	-0.51** (0.08)	0.028** (0.01)	-0.08 (0.07)	-0.03 (0.04)
Semi skimmed milk	0.34* (0.03)	-0.75** (0.01)	0.46** (0.09)	-0.30** (0.05)
Skimmed milk	-0.16** (0.01)	0.24** (0.02)	-0.82** (0.06)	-0.14** (0.02)
Enriched milk	-0.10** (0.001)	0.03 (0. 85)	-0.31** (0.01)	-0.40** (0.03)

Note: Standard errors in parentheses

* Denotes significance at the 10% level of significance

** Denotes significance at the 5% level of significance

Table 7. Estimated socio-demographic marginal effects (without brands)

	Whole milk	**Semi skimmed milk**	**Skimmed milk**	**Enriched milk**
Presence of children	0.01**	0.03	-0.081*	-0.063
	(0.004)	(0.12)	(0.065)	(0.067)
Age of the head of the household	-0.003	-0.022	0.031	0.048
	(0.004)	(0.064)	(0.036)	(0.037)

Source: Own elaboration

Note: Standard errors in parentheses

* Denotes significance at the 10% level of significance

** Denotes significance at the 5% level of significance

Table 8. Expenditure elasticities of milk categories (with brands)

	Whole milk		**Semi skimmed milk**		**Skimmed milk**		**Enriched milk**	
	Manuf. Brand	**Private label**	**Manuf. Brand**	**Private label**	**Manuf. Brand**	**Private label**	**Manuf. Brand**	**Private label**
Expenditure elasticities	0.80**	0.70**	0.82**	0.74**	0.76**	0.60**	0.84**	0.82**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.03)	(0.02)

Note: Standard errors in parentheses

** Denotes significance at the 5% level of significance

Table 9. Estimated Marshallian own price and Hicksian cross price elasticities of milk categories (with brands)

		Whole milk		Semi skimmed milk		Skimmed milk		Enriched milk	
		Manuf. Brand	Private label	Manuf. Brand	Private label	Manuf. Brand	Private label	Manuf. Brand	Private label
Whole milk	Branded	-0.60** (0.04)	0.06** (0.03)	-0.06** (0.01)	0.10* (0.06)	0.01 (0.04)	-0.02** (0.001)	-0.15 (0.17)	0.01 (0.07)
	Private label	0.07 (0.06)	-0.61** (0.001)	0.07** (0.003)	-0.03 (0.08)	-0.19 (0.22)	-0.02** (0.002)	-0.20** (0.03)	-0.54** (0.02)
Semi skimmed milk	Branded	-0.07* (0.04)	0.07 (0.08)	-0.88** (0.002)	0.01 (0.08)	0.31** (0.09)	-0.02** (0.001)	0.09 (0.07)	0.17** (0.04)
	Private label	0.13* (0.08)	-0.04 (0.09)	0.01 (0.09)	-0.72** (0.10)	0.18* (0.10)	-0.02** (0.001)	0.64** (0.10)	0.10 (0.11)
Skimmed milk	Branded	0.01 (0.03)	-0.16* (0.09)	0.26** (0.06)	0.14** (0.07)	-0.84** (0.07)	-0.02** (0.001)	0.97** (0.07)	-0.02 (0.05)
	Private label	-0.02** (0.004)	-0.02** (0.004)	-0.02** (0.004)	-0.01** (0.004)	-0.03** (0.005)	-0.73** (0.002)	-0.01 (0.01)	-0.02** (0.004)
Enriched milk	Branded	-0.11 (0.09)	-0.12** (0.04)	0.05** (0.02)	0.34** (0.11)	0.68** (0.06)	-0.02* (0.001)	-0.24** (0.07)	0.09** (0.03)
	Private label	0.01 (0.04)	-0.38** (0.02)	0.12 (0.17)	0.06 (0.07)	-0.06** (0.02)	-0.02** (0.001)	0.11 (0.09)	-0.17** (0.01)

Note: Standard errors in parentheses
* Denotes significance at the 10% level of significance
** Denotes significance at the 5% level of significance

Table 10. Estimated socio-demographic marginal effects (with brands)

	Whole milk		Semi skimmed milk		Skimmed milk		Enriched milk	
	Branded	**Private label**	**Branded**	**Private label**	**Branded**	**Private label**	**Branded**	**Private label**
Presence of children	0.007** (0.003)	0.003 (0.003)	-0.001 (0.003)	0.002 (0.003)	-0.001 (0.003)	-0.007* (0.004)	-0.002 (0.004)	0.001 (0.002)
Age of the head of the household	-0.004** (0.001)	-0.001 (0.002)	-0.003 (0.002)	-0.005** (0.002)	0.003** (0.001)	0.004** (0.002)	0.003 (0.002)	0.002 (0.005)

Note: Standard errors in parentheses

* Denotes significance at the 10% level of significance

** Denotes significance at the 5% level of significance