RedFame

Applied Economics and Finance
Vol. 6, No. 6; November 2019
ISSN 2332-7294 E-ISSN 2332-7308
Published by Redfame Publishing
URL: http://aef.redfame.com

Examining Demand Elasticities in the U.S. Differentiated Yogurt Market

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Received: September 3, 2019 Accepted: October 4, 2019 Available online: October 17, 2019

doi:10.11114/aef.v6i6.4504 URL: https://doi.org/10.11114/aef.v6i6.4504

Abstract

This article applies the Quadratic Almost Ideal Demand system (QUAIDS) model to households' weekly purchases of yogurt augmented with household characteristics to analyze consumer choices and estimate demand elasticities in the U.S. differentiated yogurt market after the introduction of Chobani brand in 2005. Results show that households with a college degree are more likely to purchase Chobani and Dannon brands rather than Yoplait and private labels. Except for Dannon, demand is price elastic, while the new brand of Chobani has a higher elastic demand compared to the Yoplait brand. Branded yogurts are expenditure elastic with the highest magnitude for Chobani among brands.

Keywords: demand, elasticity, QUAIDS, yogurt

1. Introduction

The United States dairy industry delivers a large range of dairy products. The per capita consumption of dairy products has changed over the last four decades. While the consumption of fluid milk has decreased over time, the consumption of other manufactured dairy products such as cheese, ice cream, butter, and yogurt has increased (Blayney, 2010). Yogurt is the fourth largest dairy category at the retail level (Hovhannisyan & Bozic, 2013) where its popularity is on the rise in the United States. Yogurt per capita consumption has increased from 4.0 pounds per person in 1985 to 14.7 pounds per person in 2015 (United States Department of Agriculture, 2016). This increase in demand leads to an increase in yogurt sales which based on Nielsen-measured retail channels for refrigerated yogurt were $7.7 billion in 2015.

Market demand is one of the many factors that affect the profitability of a business. Decision-makers in the dairy sector, both public and private, require contemporaneous demand analysis (Maynard & Veeramani, 2003) especially after the change in per capita consumption of major dairy products in the last decades. The decision to alter the price of a product depends on both the own-price elasticity and the cross-price elasticity of a product (Hovhannisyan & Khachatryan, 2017). How consumers respond to price changes is an important question for retailers to manage and develop their future marketing strategies to maximize their profit.

Therefore, the main objective of this study is to calculate the demand elasticities of yogurt at the brand level. We believe that this study is an important one because, to the best of our knowledge, this is the first study that estimates the demand elasticities of main brands of yogurt after the introduction of Chobani. Own-price and expenditure elasticities can provide decision-makers with the necessary information to respond properly to the rapid changes in US economic, demographic and social structures. However, for the calculated elasticities to be useful for policymakers and the industry, they should be based on valid and reliable estimates. The findings of this paper can also help retailers to target consumers using their demographic information to increase sales as each group of individuals have different preferences for each yogurt brand.

There is a limited number of studies analyzing consumer demand at the brand level in the yogurt market. Early studies identified yogurt as a single aggregated product. Boehm (1975) used household panel data from April 1972 to April 1973 to estimate household demand for thirteen major dairy products in the Southern United States. The study revealed that household consumption of dairy products in the South tend to be lower than the national average due to the higher prices of dairy products and lower household income in the South compared to the national household income. The

study suggests that an increase in income may lead to an increase in the purchases of yogurt more than other dairy products in the Southern United States.

Davis et al. (2010) used Nielsen 2005 Homescan dataset to estimate the effect of total expenditure and demographic factors that affect demand for refrigerated, frozen and drinkable yogurt using a translog demand system. The study showed that refrigerated yogurt and drinkable yogurt were net substitutes for frozen yogurt. Demographic factors found to be significant only for frozen and drinkable yogurt. The presence of children in a household had a negative impact on the demand for frozen yogurt and a positive impact on the demand for drinkable yogurt. The paper revealed that yogurt prices and household income have an important impact on the demand for yogurt.

In another study, Davis et al. (2011) used Nielsen 2007 Homescan purchase data to estimate demand elasticities for sixteen products including refrigerated and frozen yogurt using a censored Almost Ideal Demand System (AIDS) model. Both uncompensated and compensated own-price elasticities showed price elastic demand for frozen yogurt but not for refrigerated yogurt.

Most recent studies have focused on estimating demand at the brand level. Villas-Boas (2007) used different supply models to analyze the vertical relationships between manufacturers and retailers using data from a Midwestern urban area from June 1991 to June 1993. Results from a random coefficients discrete choice model revealed an average own-price elasticity of -5.48, -5.65, and -6.15 for Dannon, Yoplait, and the private label, respectively.

Mehta et al. (2010) examined demand elasticities at the brand level using a model of consumer demand proposed by Hanemann (1984). Using ACNielsen scanner level yogurt data in Sioux Falls, South Dakota market from 1986 to 1988. Authors found inelastic demand for all studied brands of yogurt where the quantity elasticities were -0.6, -0.66, and -0.85 for Dannon, Yoplait, and the private label respectively.

This paper addresses the important, but yet unanswered, question of how the demand elasticities of main yogurt brands in the United States have changed after the introduction of Chobani which was founded in 2005 and produces the majority of the country's Greek yogurt. What makes yogurt an interesting case study is its dynamic and fast-growing market (Mohammed et al., 2019). The introduction of Chobani marked a turning point in the yogurt market since it has grown into a massive force that competes with huge yogurt brands after a tiny startup. Figure 1 shows the market share of main yogurt brands in the United States in 2015 where Chobani has the highest market share among brands[i].

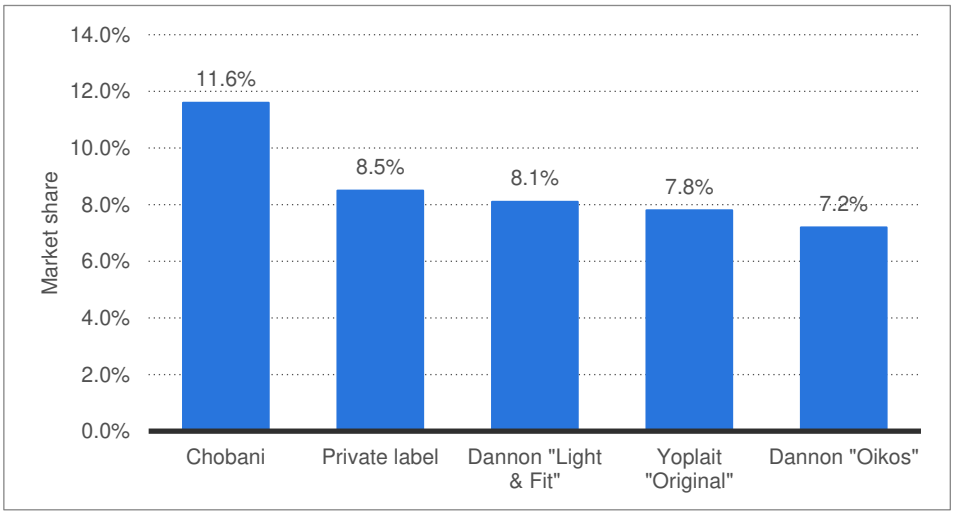

Figure 1. U.S. Yogurt Market Share for Main Brands in the United States 2015

In this study, the Quadratic Almost Ideal Demand System (QUAIDS) model is applied to 2008-2011 yogurt purchases data from 27 retailers located in Eau Claire, Wisconsin and Pittsfield, Massachusetts to estimate the demand for the main yogurt brands - Yoplait, Dannon, Chobani and the private label. Yogurt is chosen because of its fast-growing market due to greater health awareness. The availability of scanner data at the brand level and the substantial variation of yogurt and consumer characteristics, offer a good opportunity for a case study in estimating the demand elasticities. In the next section, the quadratic almost ideal demand system model is explained. Then data definitions and sources are presented following by the main findings of the study. Finally, the conclusion of this study and suggestions for future research are presented.

2. Model

The traditional approach to estimate demand systems is using the Almost Ideal Demand System (AIDS) introduced by Deaton and Muellbauer (1980). The AIDS model has budget shares that are linear functions of log total expenditure. Empirical studies on the relationships between a commodity's budget share and total expenditure which is known as the Engel curve indicate that further terms in total expenditure are required for some expenditure share equations (Lewbel, 1991; Blundell et al., 1993). Banks et al. (1997) show that a nonparametric analysis of consumer expenditure patterns suggests that Engel curves require quadratic terms in the logarithm of expenditure. They derive an extension of the AIDS model - the quadratic almost ideal demand system (QUAIDS) which also includes a higher-order total expenditure term. In this study, we estimate the demand parameters and the price and income elasticities using the QUAIDS model which has been broadly used recently by demand analysis studies of fish and meat (Lambert et al., 2006); food (Abdulai & Aubert, 2004; Bopape, 2006; Hoang, 2018), yogurt (Davis *et al*., 2010), wine (Cembalo et al., 2014), and ornamental plants (Hovhannisyan & Khachatryan, 2017).

Let q_i denote the quantity of brand i consumed by a household, and define the expenditure share for brand i as $w_i = p_i q_i / m$ where p_i is the price of brand *i* and m is the household total expenditure, the QUAIDS model in budget shares is (Banks et al., 1997):

$$w_i = \alpha_i + \sum_{j=1}^{k} \gamma_{ij} \ln p_j + \beta_i \ln\left\{\frac{m}{a(\mathbf{p})}\right\} + \frac{\lambda_i}{b(\mathbf{p})}\left\{\ln\left[\frac{m}{a(\mathbf{p})}\right]\right\}^2 \quad (1)$$

where **p** is a vector of prices, $a(\mathbf{p})$ is a function that is homogeneous of degree one in prices, $b(\mathbf{p})$ is a function that is homogeneous of degree zero in prices, α_i, β_i, γ_{ij}, and λ_i are parameters to be estimated. Adding-up requires that $\sum_i w_i = 1$.

Notice that when $\lambda_i = 0$ for all *i*, the quadratic term in each expenditure share equation drops out and we are left with Deaton and Muellbauer's (1980) original AIDS model. Hence, the AIDS model is nested within QUAIDS, the AIDS specification can be tested based on the statistical significance of the λ's.

Sociodemographic variables are typically incorporated into demand system analysis through the linear demographic translation method of Pollak and Wales (1978) to control for varying preference structures and heterogeneity across households. Let $h = 1, \ldots, N$ denote households, the budget shares equations for household h can then be represented as follow[ii]:

$$w_{ih} = \alpha_i + \sum_{j=1}^{k} \gamma_{ij} \ln p_{jh} + \beta_i \ln\left\{\frac{m_h}{a(\mathbf{p}_h)}\right\} + \frac{\lambda_i}{b(\mathbf{p}_h)}\left\{\ln\left[\frac{m_h}{a(\mathbf{p}_h)}\right]\right\}^2 + \sum_{s=1}^{S} \delta_{is} z_{sh} + v_{ih} \quad (2)$$

where $z_s = (z_{1h}, \ldots, z_{sh})$ is a set of demographic variables for household h. Commodity prices are indexed with the household superscript because households in different clusters face different prices at the store level.

In most scanner-level data, prices are not observed directly and it must be calculated from the dollars paid by the household during each shopping trip where the calculated price is more likely endogenous. Since the difference between different brands of yogurt is small, we argue that the effect of price endogeneity on estimation is very small (see Chen et al.,2018 for more detail). In the same way, how much of each brand to buy and how much to spend on yogurt is another household's decision that makes the expenditure endogeneity. Expenditure endogeneity is also arising by other unobserved components in the budget share equations. Therefore, we include household income and family size as instruments in addition to the price index in the demand equation and other sociodemographic variables to augment the demand system (see Dhar, et al., 2003; Thompson, 2004; Xiong, et al., 2014). The total expenditure equation has a reduced form and is jointly estimated with the demand system:

$$\ln m_h = z'\omega_h + \vartheta \ln \mathbf{p} + k_1\, income_h + k_2\, income_h^2 + k_3\, size_h \quad (3)$$

where ω is a vector of sociodemographic variables explaining the total expenditure, and z is the corresponding conformable vector parameter vector.

Handling a large number of "zero" purchases is one of the econometric challenges in the analysis of consumer survey data (Deaton, 1997). In the differentiated yogurt market, the percentages of zero-brand consumption (censoring) are severe. Each of Chobani and private label yogurt is consumed by 32 percent of households while Dannon and Yoplait are consumed by 83 and 91 percent of households respectively. In the demand literature, several approaches are introduced to handle left-censoring after the primal approach of Kuhn-Tucker (Wales &Woodland, 1983).

Most recently, Yen et al. (2003) proposed a quasi-maximum likelihood estimator (QML) to estimate the censored demand system by dropping the *n-th* good equation as a residual category and estimating the resulting *n-1* equation system with the identity $\widehat{w}_{nh} = 1 - \sum_{i=1}^{n-1} \widehat{w}_{ih}$. The QML procedure had not been applied in censored demand estimation because of its computational challenge as it requires evaluating multiple probability integrals. Another disadvantage of this procedure is that the resulting estimates are not invariant to the dropped equation, and $\widehat{w}_{nh}$ could sometimes be negative (Garcia-Enriquez et al., 2016). The two-step procedure developed by Shonkwiler and Yen (1999) considers an alternative procedure that produces consistent parameter estimation. However, this procedure is less efficient than MLE (Yen and Lin, 2006). Nevertheless it remains an attractive alternative and it is still widely used in empirical literature (Sckokai & Moro, 2009; Schrock, 2012; Khaliukova, 2013; Hailu *et al*., 2014; Hovhannisyan & Khachatryan, 2017; Chen et al., 2018) due to its simplicity. Therefore, we apply this procedure in this paper.

Shonkwiler and Yen (1999) derive the unconditional mean of the expenditure share for yogurt brand *i* such that:

$$E(w_{ih}) = \Phi(z'_{ih}, \tau_i) w_{ih}(\mathbf{p}_h, m_h; \psi) + \delta_i \varphi(z'_{ih}, \tau_i) \tag{4}$$

where $\Phi(.)$ and $\varphi(.)$ are the cumulative distribution function and standard normal probability density function, respectively, ψ is a vector containing all parameters in a particular demand equation, z_{ih} is a vector of exogenous variables governing the purchasing decision, and τ_i is a conformable vector of parameters.

Estimation of budget share equations can be performed in two steps: in the first step, known as the purchase decision, the maximum-likelihood probit estimates $\hat{\tau}_i$ of τ_i are obtained[iii] using the binary outcomes of $w_{ih} = 0$ and $w_{ih} > 0$, and then in the second step calculate $\Phi(z'_{ih}\hat{\tau}_i)$ and $\varphi(z'_{ih}\hat{\tau}_i)$ for all *i* and estimate ψ and δ's in the augmented system:

$$w_{ih} = \Phi(z'_{ih}, \hat{\tau}_i) w_{ih}(\mathbf{p}_h, m_h; \psi) + \delta_i \varphi(z'_{ih}, \hat{\tau}_i) + \varepsilon_{ih} \tag{5}$$

with maximum likelihood estimation (MLE) or seemingly unrelated regression (SUR) where $\varepsilon_{ih} = w_{ih} - E(w_{ih} \mid \mathbf{p}_h, m_h, z_h)$. Note that the disturbance terms in equation (5) are heteroscedastic (Shonkwiler & Yen, 1999) which can be corrected for using robust standard errors (Hailu et al., 2014).

A major drawback of Shonkwiler and Yen (1999) procedure is that the adding-up property of the demand system cannot be imposed any longer (see, Drichoutis et al., 2008). The adding-up complication using this procedure is addressed using Pudney's (1989) approach by treating one brand of yogurt as a residual category and estimates its expenditure as the difference between total expenditure and expenditure on all other yogurt brands. Therefore, private label is considered as a residual category. After imposing homogeneity and symmetry restrictions, expenditure elasticities of non-residuals categories are derived by differentiating the budget share equations of (5) with respect to ln *m*. Expressions are simplified using the intermediate results following Banks et al. (1997):

$$\mu_i \equiv \frac{\partial E(w_i)}{\partial \ln m} = \Phi(z'_i\hat{\tau}_i)\frac{\partial w_i}{\partial \ln m} = [\Phi(z'_i\hat{\tau}_i)].\beta_i + \frac{2\lambda_i}{b(\mathbf{p})}\left\{\ln\left[\frac{m}{a(\mathbf{p})}\right]\right\} \tag{6}$$

$$e_i = 1 + \frac{\mu_i}{w_i} \tag{7}$$

In the same way, Marshallian or uncompensated price elasticities of non-residual categories are derived by differentiating the budget share equations with respect to ln p_j. Using expression μ_{ij} , the formula for the Marshallian price elasticities can be written as:

$$\mu_{ij} \equiv \frac{\partial E(w_i)}{\partial \ln p_j} = \Phi(z'_i\hat{\tau}_i)\frac{\partial w_i}{\partial \ln p_j} \tag{8}$$

$$\mu_{ij} = [\Phi(z_i'\hat{\tau}_i)].\gamma_{ij} - \mu_i\left[\alpha_j + \sum_{l=1}^{K}\gamma_{jl}\ln p_l\right] - \frac{\lambda_i\beta_j}{b(\mathbf{p})}\left\{\ln\left[\frac{m}{a(\mathbf{p})}\right]\right\}^2 \quad (9)$$

$$e_{ij}^u = \frac{\mu_{ij}}{w_i} - \delta_{ij} \quad (10)$$

where δ_{ij} is the Kronecker delta equals 1 if $i = j$ and 0 otherwise.

Using the Slutsky equation, the Hicksian or compensated price elasticities of non-residual categories are calculated:

$$e_{ij}^c = e_{ij}^u + w_j e_i \quad (11)$$

Estimated elasticities of non-residual categories can be used to calculate elasticities of the residual category. Therefore, the adding-up theoretical restrictions from the demand theory can be met (Yen et al., 2003). Note that expenditure, the Marshallian, and Hicksian elasticities for the residual category can be calculated using the budget constraint (Yen et al., 2003):

$$\sum_{i=1}^{n} w_i\, e_{ij} = -w_j, \sum_{i=1}^{n} w_i\, e_{ij}^* = 0, \sum_{i=1}^{n} w_i\, e_{im} = 1 \quad (12)$$

3. Data

Data used in this study is household weekly purchases from 27 retailers collected by Information Resource Inc. (IRI). The data is at the chain level from the city of Eau Claire in Wisconsin and the city of Pittsfield in Massachusetts for the period 2008-2011. These datarepresents the most recent years that were available to us. This database consists of a representative panel of about 4200 households who made about 520 thousand purchases during this period. The data provides information for each product at the Universal Product Code (UPC) level, dollar amount paid, volume of purchases, retailers, and weeks. Information on product characteristics are obtained from the product category dataset, which contains information on brand, volume equivalent, flavor, fat content, and organic information. Using volume equivalent information, the volume of purchases is converted to a brand quantity and then retail prices are obtained from brand quantity and dollar amount paid information.

This study focuses on brands with the highest market shares which are Yoplait, Dannon, and Chobani respectively, in addition to the private label which comes in the fourth place. Table 1 presents the summary statistics of yogurt brands. After dropping observations with key explanatory variables missing, the sample size is 25,372. Data is complemented with a college dummy variable equals 1 if the household head has a college degree and above, in addition to a child dummy if households have children. Income of the household and the family size are also used as instrumental variables to deal with the endogeneity bias caused by the expenditure on yogurt. This information is also obtained from the panel demographics dataset provided by IRI for the actual yogurt consumers, which are 5142 households, who made purchases during the year of 2008-2011. Table 2 presents the summary statistics of household demographic variables.

Table 1. Summary Statistics of Yogurt Prices, Quantity Purchased, and Market Shares

	Chobani	Dannon	Yoplait	Private Label
Retail prices ($/6 oz)				
	1.197	0.724	0.674	0.492
	(0.171)	(0.249)	(0.215)	(0.129)
Quantity purchased by HH (oz)				
	4.310	26.4	41.047	4.174
	(18.44)	(47.32)	(64.99)	(19.24)
Customers HH (%)				
	32.65	83.06	91.17	32.54
Market share (%)				
	6.58	30.86	57.07	5.49

Note. Numbers in parentheses are standard deviations.

Table 2. Summary Statistics of Sociodemographic of the Sample Households

Variable	Mean	Std. Dev.	Min	Max
College	0.170	0.375	0	1
Children	0.204	0.403	0	1
Family size	2.388	1.243	1	8
Income*	7.201	3.253	1	12

* in (10,000)

4. Results

4.1 Demand Parameter Estimates

Table 3 reports the estimation results from the first step probit models to interpret the sociodemographic and price effects on yogurt purchases in terms of probabilities. Even though probit models are estimated to compute the probability and the cumulative density values, this step is also aimed to show that the buying decision does not occur randomly, and to determine the variables that predict it. As mentioned in the model section, the dependent variable in the probit model is a binary variable taking a value of one if positive purchase occurs by households for a specific brand and zero otherwise; while the explanatory variables are: the household income, a dummy variable for a household head with a college degree, a dummy variable for a presence of children in a household, and log of prices.

Table 3. First Stage Probit Estimation

Variables	Chobani	Dannon	Yoplait	Private
College	0.230***	0.155***	-0.060	0.057
	(0.050)	(0.058)	(0.069)	(0.049)
Child	-0.172	0.162***	0.654***	-0.020
	(0.047)	(0.055)	(0.085)	(0.046)
Income	0.043***	0.025***	0.022***	0.012**
	(0.005)	(0.006)	(0.007)	(0.005)
In P_1	-1.156***	-0.600***	0.391	-2.319***
	(0.199)	(0.244)	(0.305)	(0.214)
In P_2	0.640***	-0.272***	-0.307***	-0.395***
	(0.083)	(0.097)	(0.107)	(0.081)
In P_3	1.090***	0.397***	-0.333**	0.401***
	(0.098)	(0.099)	(0.134)	(0.093)
In P_4	0.939***	0.425***	-0.392***	0.587***
	(0.098)	(0.113)	(0.130)	(0.095)
Constant	-0.774***	1.277***	1.169***	2.029***
	(0.243)	(0.296)	(0.371)	(0.259)

Note. Numbers in parentheses are standard deviations. ***, ** and * indicate significant at 1%, 5% and 10% respectively.

Households' head with a college degree are more likely to purchase Chobani and Dannon brands rather than Yoplait and the private label. Families with children in the household tend to purchase Dannon and Yoplait which have lower prices compared to Chobani. An increase in income will increase the probability of purchasing branded yogurt which has higher prices compared to the private label. In general, the effect of an increase in the price of the brand will decrease the probability that households buy the given brand where most parameters related to own prices are negative and significant.

Table 4. Parameter Estimates from the Nonlinear AIDS Demand System

Parameters	Coefficients	Standard Errors	Parameters	Coefficients	Standard Errors
α_1	-0.035	0.053	γ_{43}	-0.076***	0.016
α_2	0.320***	0.055	γ_{44}	0.022	0.025
α_3	0.585***	0.054	δ_{11}	0.119***	0.017
α_4	0.130*	0.068	δ_{12}	0.007	0.016
β_1	-0.116***	0.042	δ_{13}	-0.073***	0.015
β_2	-0.116***	0.037	δ_{14}	-0.053***	0.013
β_3	0.125***	0.035	δ_{21}	-0.005	0.019
β_4	0.108***	0.034	δ_{22}	-0.056***	0.020
γ_{11}	-0.484***	0.054	δ_{23}	0.029	0.020
γ_{12}	0.058**	0.023	δ_{24}	0.031	0.022
γ_{13}	0.266***	0.029	δ_{31}	0.023***	0.003
γ_{14}	0.159***	0.029	δ_{32}	0.005*	0.003
γ_{21}	0.058**	0.023	δ_{33}	-0.015***	0.002
γ_{22}	0.066***	0.023	δ_{34}	-0.013***	0.003
γ_{23}	-0.019	0.018	λ_1	0.032	0.027
γ_{24}	-0.106***	0.021	λ_2	0.058**	0.026
γ_{31}	0.266***	0.029	λ_3	-0.036	0.025
γ_{32}	-0.019	0.018	λ_4	-0.054***	0.021
γ_{33}	-0.172***	0.024	φ_1	0.263***	0.041
γ_{34}	-0.076***	0.016	φ_2	-0.283***	0.107
γ_{41}	0.159***	0.029	φ_3	0.150	0.120
γ_{42}	-0.106***	0.021	φ_4	-0.129	0.160

Note. Numbers in parentheses are standard deviations. ***, ** and * indicate significant at 1%, 5% and 10% respectively.

Parameter estimates from the nonlinear AIDS demand system are presented in Table 4. The significance of estimated coefficients of λ's allows us to choose easily between the original AIDS and the quadratic AIDS model. The null hypothesis that λ_i is zero in the budget share equation is rejected for Dannon and the private label. As a result, the quadratic AIDS model is preferred for the demand estimation at the brand level in this study.

4.2 Elasticities

Elasticities are used to interpret the effect of yogurt price and household income on yogurt purchases. An examination of the expenditure elasticities is shown in the last column of Table 5 where all the estimates, except for the Private label, are statistically significant. The positive sign of estimated expenditure elasticities indicate that all these brands can be considered as normal goods. Demand for Chobani is more than unitary elastic which makes this brand a luxury good. A 1% increase in the household income will increase household expenditure on Dannon and Yoplait by 1.2% and 1.01%, respectively. Demand on a new brand of Chobani will substantially increase by 1.67% as an income of a household increases by 1%.

Table 5 also reports uncompensated and compensated price elasticity estimates evaluated at the sample means along with the associated standard errors. Most estimates are statistically significant. Dannon has the lowest uncompensated own-price elasticity (-0.35) followed by the elastic demand of Yoplait (-1.62). The inelastic demand for Dannon reveals the popularity of this brand among yogurt consumers. Based on data from IRI in 2011, Danone comes in 84 different flavors where strawberry, blueberry, and vanilla are the most popular respectively. Chobani with the highest price among branded yogurt has the highest uncompensated own-price elasticity (-6.84). One possible reason why Chobani demand elasticity is of greater magnitude compared to other branded yogurt is the fact that Chobani was a new brand at that time and it was not very popular nationally and only 16 different flavors were offered on the market. Private label has a high uncompensated own-price elasticity (-3.43), but it is lower than the price elasticity of Chobani.

Villas-Boas (2007) found an average elastic own-price elasticity of -5.48, -5.65 and -6.15 for Dannon, Yoplait, and the private label respectively using Berry Levinsohn Pakes (BLP) model. Mehta et al. (2010) found inelastic demand of -0.6, -0.66, and -0.85 for Dannon, Yoplait, and the private label respectively using an integrated framework proposed by Hanemann model. It can be noticed that our estimates are not consistent with the elastic demand of the first study and inelastic demand for the second study. One possible reason is that each study peruses different markets during different periods. Our study investigates the yogurt market after a change in market competition by the introduction of Chobani in 2005. Compared to the former paper, after the introduction of Chobani, each of Yoplait and private labels lost their magnitude in terms of elasticity but they are still elastic while demand for Dannon became inelastic.

Table 5. Own-Price, Cross-Price, and Expenditure Elasticities Estimates

	Price Elasticities				Expenditure Elasticity
Uncompensated	Chobani	Dannon	Yoplait	Private	
Chobani	**-6.841*** **	2.992***	6.367***	4.31***	1.669**
	(1.178)	(0.59)	(0.63)	(0.749)	(0.66)
Dannon	0.419***	**-0.35*** **	0.478***	0.077	1.155***
	(0.156)	(0.097)	(0.111)	(0.116)	(0.149)
Yoplait	0.292***	-0.308***	**-1.616*** **	-0.383***	1.019***
	(0.103)	(0.06)	(0.068)	(0.066)	(0.098)
Private	1.937	-6.076***	-5.948***	**-3.425*** **	-1.007
	(1.186)	(0.905)	(0.837)	(1.048)	(0.771)
Compensated	Chobani	Dannon	Yoplait	Private	
Chobani	**-6.731*** **	3.566***	7.284***	4.379***	
	(1.157)	(0.581)	(0.762)	(0.74)	
Dannon	0.495***	**-0.047**	1.113***	0.125	
	(0.149)	(0.094)	(0.147)	(0.113)	
Yoplait	0.359***	0.042	**-1.056*** **	-0.34***	
	(0.098)	(0.058)	(0.091)	(0.064)	
Private	1.87	-6.423***	-6.501***	**-3.467*** **	
	(1.156)	(0.909)	(1.006)	(1.043)	

Note. Bold numbers are own-price elasticities. Standard errors are in parentheses. *** and ** indicate significant at 1% and 5%, respectively.

Relationships among yogurt groups are also identified by estimated compensated cross-price elasticities. Most cross-price elasticities are positive and significant, indicating yogurt brands are substitutes, but the substitution among groups is asymmetric. An increase in the price of Chobani will increase the demand for Dannon, Yoplait, and the private label substantially, while an increase in the price of Dannon will not increase the demand for Chobani. In the same way, an increase in the price of Dannon will increase the demand for Yoplait, while an increase in the price of Yoplait will not increase the demand for Dannon.

5. Conclusion

The brand of yogurt considers an important attribute affecting consumers purchasing decisions. The main objective of this study is to estimate the demand elasticities at the brand level in the yogurt market. This study is motivated by the study of Villas-Boas (2007) where the author investigates a high elastic demand for major players in the yogurt market. This paper seeks to investigate the change in demand elasticities after the introduction of one of the recent most popular brands of Chobani. The analysis employed households' yogurt purchases from two cities in the states of Massachusetts and Wisconsin, and their demographic characteristics from IRI. Results indicate that the demand for a new brand of Chobani is substantially elastic compared to other main brands of Dannon and Yoplait. Households with a college degree are more likely to buy Chobani, while an increase in income will increase the demand for all branded yogurt.

The concept of price elasticity of demand is important for formulating government policies, like the taxation policy or the policy of protection. Any regulation that might lead to an increase in the price of milk, for example, would affect the yogurt production costs, and then its market revenues. The brand of Chobani would be highly affected by such a policy due to its high elastic demand. The knowledge of elasticity of demand is also essential for management in the determination of price to earn maximum profit. If the demand for a product is elastic, like the Chobani brand, the producer should charge a low price, whereas, for an inelastic demand, like the Dannon brand, the producer can charge a high price for it. Furthermore, the knowledge of income elasticity is essential for management for demand forecasting of producible goods in the future. Finally, retailers can target consumers using their demographic information to increase sales as each group of individuals has different preferences for each yogurt brand. As shown in Table 3, for example, families who have children in the household tend to purchase Dannon and Yoplait than the higher-priced brand of Chobani.

Unfortunately, IRI provides only the demographic information for two states of Massachusetts and Wisconsin which is a big data limitation of this study. This limitation provides an interesting direction for future research to widen the geographical scope of yogurt demand study to the entire U.S. market. Another extension of this study would be assuming different supply models like the widely used Bertrand-Nash pricing model, a leader-follower (Stackelberg) framework, or a joint-profit maximization (monopoly) game, to provide the market power each brand has in the yogurt market. Yoplait maker General Mills has launched a new "French-style" yogurt called "Oui" in July 2017 which would a very interesting topic for future studies to analyze the effect of this new product's introduction to the yogurt market.

Acknowledgments

The authors acknowledge the Department of Agricultural and Applied Economics at Texas Tech University for their support. The authors thank the editor and two anonymous reviewers of this journal for their helpful comments and suggestions. Any remaining errors are solely the responsibility of the authors.

Authors' contributions

RM analyzed the data and wrote the first draft. OM provided the data and critically reviewed the manuscript. Both authors read and approved the final manuscript.

Availability of data and material

Data are available on request to the corresponding author.

Funding

Not applicable.

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[i] https://www.statista.com/statistics/548377/us-market-share-of-yogurt-by-company/

[ii] Notice that the price index and the cobb-Douglas price aggregator will be indexed by *h*.

[iii] Notice that the dependent variable is the positive expenditure share while the explanatory variables are sociodemographic exogenous variables of households that affects the purchase decision in addition to the brands' prices.