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The effect of variety offering on demand and supermarket competition: yogurt in the Houston metropolitan area

Abstract

The objective of this paper is to estimate the effect of pricing and variety offering on consumers' utility and supermarket chains' profits for yogurt products. Specifically, the authors analyze yogurt demand at the supermarket-brand level, examine the effect of variety on consumer demand and supermarket pricing conduct, and test for and measure market power of the respective supermarket chains. The demand results show that consumers are more likely to purchase a certain yogurt brand if the variety offering of that brand increases. In addition, consumer price sensitivity increases as the authors take into account the variety offering. The magnitude of the own-price elasticity increases as the price-variety interaction is included in the indirect utility. Therefore, ignoring this interaction would yield underestimated (in absolute value) elasticities and consequently overestimated price-cost margins.

With respect to supply, the results indicate that supermarket chains exercise some degree of market power when selling yogurt products. However, the degree of market power is reduced as more variety is offered, mainly because of an increase in marginal cost and consumer price sensitivity. In addition, the results suggest that supermarket chains make more money selling their own brands. This creates a conflict for the supermarket chains. On one hand, consumers want greater variety, forcing the retailer to offer more national brands. On the other hand, increasing variety raises retailers' marginal cost and ultimately retail prices, which in turn can affect demand.

Keywords: variety, logit, supermarkets, yogurt.

Introduction

The diversity of consumers' tastes and preferences can lead to a proliferation of differentiated products, even when consumers use only a few product attributes in their choice decisions. Thus, the variety of products offered can represent an important factor when making purchasing decisions. Recent research has shown a greater variety of options that can cater to a wider range of tastes and preferences (Lancaster, 1990). That is, with greater product variety, the quality of the product, as perceived by consumers, increases.

Traditional economic theory does not account for variety. It implies that strategic choices are limited by product prices and production, and that competition is perfect; all firms are considered identical and no competitive advantage based on strategic differences exists. Similarly, in the case of monopoly, characterized by a lack of economic competition and control by a single firm, there is no need for variety. In contrast, oligopolistic competition gives rise to a wide range of different outcomes. Among these outcomes, lies the intriguing issue of the variety offering. Some studies of product differentiation indicate that oligopolies might create excessive levels of product variety, where each firm differentiates its products in order to stand out from other firms' offerings and consequently stifle the competition (Miles et al., 1993).

There have been numerous studies of product variety. These studies can be grouped in three categories. The first stresses the effect of variety on consumer choices.

For instance, Berger, Draganska and Simonson (2006) studied the influence of product variety on brand perception and choice decision. They conducted six studies designed to test their assumptions and predictions about product variety. These authors found that brands with many varieties are perceived as having higher quality due to a greater number of options catering to a wider range of tastes, and a higher perceived quality led to a higher choice share of brands offering greater product variety.

In addition, Brynjolfsson, Smith and Hu (2003) used welfare estimation techniques to measure the consumer welfare gain from increased product variety that is available through electronic markets. Using data from online bookstores, their research shows that increasing product variety in online bookstores enhanced consumer welfare by \$731 million to \$1.03 billion in the year of 2000. Along the same line, Rossi et al. (2006) analyzed consumer demand for yogurt variety. The authors conclude that if a supermarket chain was to delete a yogurt flavor from the shelves, consumers may lose utility and consequently reduce their consumption and visits to that supermarket. Therefore, any decrease in variety offering should be accompanied by a price reduction in order to compensate consumers for the loss of utility induced by reduced variety.

The second category of studies deals with the effect of variety offering on firms' performance and competition. Macduffie et al. (1996) studied the effect of product variety on manufacturing performance. This study analyzed 70 automotive assembly plants, using a data set from the international motor vehicle program (MIT). It revealed that product variety is

“good” only if it provides market place advantages at little cost, and is “bad” if it offers no value to customers, no matter what the cost is. In addition, a company that can minimize its cost of product variety has more flexibility in choosing how much variety to offer in the market place.

Furthermore, Allain and Waelbroeck (2006) examined the relationship of horizontal and vertical market structure, and variety in products. The authors summarize their findings in three main points. First, a vertically integrated structure offers a larger variety of products. Second, retail concentration reduces product variety, mainly because more incentives exist to extend its product line for a producer facing competing retailers than when faced with a more concentrated retail industry. Finally, competition between retailers can lead to even more product variety than that found under a vertically integrated structure because of increasing vertical inefficiencies.

In addition, Caminal and Granero (2008) evaluated the role of multi-product firms in the market provision of product variety using the Spokes model of non-localized competition. They compared product variety generated by a single-product as well as multi-product firms. The authors found that multi-product firms cannot exceed single-product firms in terms of competition level, and can emerge only when economies of scope are sufficiently strong.

Moreover, variety may be higher or lower under duopoly, depending on the monopolistically competitive equilibrium.

The third category of studies focuses on the variety offering from both consumers' and firms' viewpoints. Champsaur and Rochet (1986) define variety offering as a result of the number of firms existing on the market, offering a single or a variety of options. Their main interest was to find the reasons for which the firm is differentiating its products. The model they used takes into consideration consumers' attributes and the presence of product substitutes.

Another example is offered by Lancaster (1990). Lancaster has a slightly different definition of product variety. In his paper, he attempted to survey the problem of product variety from the economist's point of view. From his survey he concluded that the variety of offerings within a product group persists due to many important factors that generally guarantee variety in the market. His analysis dealt with the individual consumer, where consumer choices are studied in light of individual personal tastes and preferences. His study also dealt with the main motivations of the individual firm for producing different products. Lancaster concluded that the degree of product variety increases with the degree of competitiveness in the

market, and decreases when consumers view similar products as satisfactory substitutes.

The overall objective of this paper is to estimate the effect of pricing and variety offering on consumers' utility and supermarket chains' profits for yogurt products. Specifically, we analyze yogurt demand at the supermarket-brand level, examine the effect of variety on consumer demand and supermarket pricing conduct, and test for and measure market power of the respective supermarket chains. This work contributes to the existing literature in many aspects. First, the data used is highly disaggregated, allowing us to estimate demand at the supermarket level, which is the relevant point of consumer' purchasing decision-making. Second, to our knowledge this is the first study that investigates the effect of variety offering on pricing conduct. Previous works address only the effect of variety on demand. This study, however, assumes that the variety offering is exogenous.

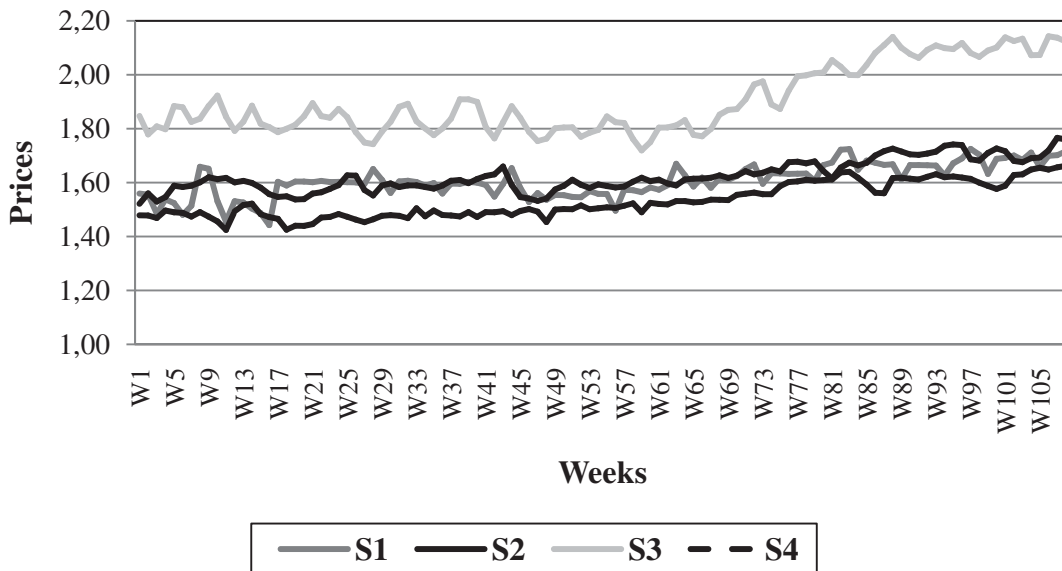
Understanding the effect of variety on demand and pricing conduct is not only relevant for researchers, but also policy makers and retail chains. From the policy maker's perspective, the estimation of pricing conduct (market power) helps better shape antitrust and merger laws (Perloff et al., 2007). From the retailer's standpoint, understanding consumer trade-offs between variety offering and prices can help them anticipate and answer consumers' needs more appropriately.

The yogurt market is an interesting case study where variety brand proliferation represents a non-price competition between firms. In fact, the number of brands of yogurt has recently expanded significantly. In addition, the U.S. yogurt market has been growing strongly in response to increased demand for the product. The U.S. market was \$300 million in 1980 but had grown to \$3.5 billion in 2005, according to Data Monitor Profile. Yogurt manufacturers, looking to efficiently match the preferences of heterogeneous consumers, have started to launch different yogurt products into the market. As a result, yogurt is available in many forms and flavors, fulfilling food trends that satisfy consumer needs.

Furthermore, the variety of products sold is quite different across supermarket chains. Some studies explain this difference as the ability of each retailer to maintain the cost of storage for these products (Chintagunta et al., 2002; and Sprott et al., 2003). Other studies find that a retail store offering a larger variety of products may attract more consumers compared to its competitors, regardless of the product prices (Brynjolfsson et al., 2003; and Berger et al., 2007). In addition, there is a trade-off between variety offering and pricing behavior. On the one hand, more variety implies higher costs due to shelf space limitations and can lead to

higher retail prices. On the other hand, limiting the variety offering decreases consumer's utility, for which retailers compensate by lowering prices. For instance, scanner data for yogurt products indicates that different supermarket chains offer a different number of yogurt brands and charge different retail

prices for the same product (see Figure 1)¹. This raises two questions. First, to what extent does variety offering affect the demand for yogurt? Second, what is the difference in retail prices explained by variety offering, cost structure, and pricing competition (market power) between retail chains?



Note: S_i is a supermarket chain ⁱ.

Fig. 1. Retail prices across three supermarket chains in Houston metropolitan area

1. The model

1.1. Demand side. The starting point here is a consumer i facing $j = 1, \dots, J$ alternative yogurt brands. The consumer chooses a brand from competing brands, in order to maximize his or her utility, taking into account the characteristics of the brand chosen. The consumer also has the opportunity to shop from other brands and other store formats (the outside option). The indirect utility function for consumer i , from choosing brand j , is given by

$$U_{ij} = \alpha p_j + \beta x_j + \mu V_j + \omega p_j V_j + \varepsilon_{ij}, \quad (1)$$

$$i = 1, \dots, N \quad j = 1, \dots, J,$$

where x_j and p_j represent respectively the observable product characteristics and price for brand j . V_j denotes variety offering of yogurt brand j (flavors, light), and $p_j V_j$ is the interaction between price and variety. ε_{ij} represent the distribution of consumer

preferences about the unobserved product characteristics, with a density $f(\varepsilon)$ are the parameters to be estimated.

Assuming the error terms are *i.i.d.* extreme value of the traditional multinomial logit model is given by:

$$s_j = \frac{\exp(\alpha p_j + \beta x_j + \mu V_j + \omega p_j V_j)}{1 + \sum_{k=1}^J \exp(\alpha p_k + \beta x_k + \mu V_k + \omega p_k V_k)} \quad (2)$$

To complete the model and define the market, an outside option is included to give the consumer the option not to buy any brand in the choice set. The utility of the outside option is normalized to be constant over time and equal to zero. In addition, the usual assumption is made that consumers buy only one unit of the category chosen. The market share of the outside option is given by

$$s_0 = \frac{1}{1 + \sum_{k=1}^J \exp(\alpha p_k + \beta x_k + \mu V_k + \omega p_k V_k)} \quad (3)$$

Taking the natural logarithm of the ratio of the market share of the brand j with respect to the outside option yields

$$\ln\left(\frac{s_j}{s_0}\right) = \alpha p_j + \beta x_j + \mu V_j + \omega p_j V_j. \quad (4)$$

¹ The figure was constructed using data from Information Resource Inc. A thorough description is presented in the data section.

² For confidentiality, the names of the supermarket chains are not revealed. In addition, S1, S2, S3 represent specific supermarket chains, while S4 represents the residual supermarket chains (others). Because the fourth chain in the sample includes all residual retailers, only the three biggest chains are discussed in the paper.

The price elasticities of the market share are then given by

$$\eta_{jk} = \frac{\partial s_j}{\partial p_k} \frac{p_k}{s_j} = \begin{cases} (\alpha + \omega V_j)(1 - s_j)p_j & \text{for } j=k \\ -(\alpha + \omega V_j)p_k s_k & \text{otherwise} \end{cases} \quad (5)$$

Notice that the elasticities are a function of variety offering. A positive parameter ω will imply a reduction in the magnitude of price sensitivity. This suggests that if consumers value variety offering, their price sensitivity decreases and they are willing to pay higher prices for higher variety offering.

1.2. Supply side. The starting point is a supermarket r , selling $j = 1, \dots, J$ different brands of yogurt. The r^{th} supermarket's problem is to maximize its profits given by

$$\pi^r = \sum_{j=1}^J (p_j^r - MC_j^r) s_j^r M, \quad (6)$$

where p_j^r is the price of the j^{th} yogurt brand sold in supermarket r , MC_j^r is the corresponding marginal cost, and s_j^r is the market share of yogurt brand j sold in supermarket r . M is a measure of potential market size¹. Assuming Nash-Bertrand equilibrium in prices, the first-order conditions for the profit function with respect to the prices are given by

$$\frac{\partial \pi^r}{\partial p_j^r} = s_j^r + \sum_{k=1}^J (p_k^r - MC_k^r) \frac{\partial s_k^r}{\partial p_j^r} = 0. \quad (7)$$

Repeating the same procedure for each supermarket and stacking the results together, we get the price-cost margins (PCM) as

$$PCM = (p - MC) = -(\Delta_s)^{-1} s, \quad (8)$$

where Δ_s is the matrix of price response with general element (j, k) given by $\Delta_s(j, k) = \frac{\partial s_j^r}{\partial p_k^r}$. This

ratio depends on the variety offering component². Consequently, the PCMs are also dependent on the variety offering. In addition, the PCMs are not econometrically estimated; rather, they are computed using the demand results. Moreover, no cost data is needed to estimate the PCMs. In addition, once the

PCMs are computed one can recover the marginal cost of each brand at each supermarket.

The Lerner index is used to assess the market power, which is the ability of a firm to alter the market price and raise it over its cost. Numerous empirical studies have examined the degree of market power of many different firms in many different markets (see Church and Ware (2000) for a survey). The Lerner index is defined by

$$L_j^r = \frac{(p_j^r - MC_j^r)}{p_j^r} = \frac{PCM_j^r}{p_j^r}. \quad (9)$$

The Lerner index ranges from 0 for perfect competition to 1 for monopoly. Values of L between 0 and 1 indicate some degree of oligopoly power.

2. Data and estimation issues

2.1. Data. To estimate the model described above, we use scanner data from Information Resource Inc. for yogurt sales in the Houston metropolitan area. This data spans from the first week of March 2006 to the third week of March 2008. It includes weekly dollar sales, unit sales, and volumes sales for different brands of yogurt in three supermarket chains in the Houston metropolitan area (for confidentiality, the names of the supermarkets are not given. In what follows, we will refer to supermarket chains by S1, S2, and S3). In addition, a fourth retail outlet (S4) is included to take into account the remaining sales in the Houston market area. Because the fourth chain in the sample includes all residual retailers, only the three biggest chains are discussed in the results presented in the following section.

For this study, 11 brands of yogurt and yogurt drinks are selected, representing 36% of the total market in Houston. The retail prices of yogurt brands are found by dividing the dollar sales of each brand of yogurt by corresponding volume sales, and then deflated by the consumer price index for the city of Houston. The market shares are computed by dividing the volume sales of each brand at each supermarket by the potential market size.

Brand characteristics are collected from the nutrition facts at the products' websites. Three characteristics are considered: sugar, fat, and calorie contents. Here, we assume that product characteristics did not change between 2006 and 2008, the period of this study. The variety component is measured by the number of items offered each week. Tables 1 and 2 provide the descriptive statistics of the data used in this study.

2.2. Estimation issues. The analysis is conducted using a set of 11 brands sold in four supermarket chains in the Houston metropolitan area. We assume that the same manufacturer brand sold at different supermarket chains is considered different. For in-

¹ In this case, the market size is defined by multiplying the per capita consumption by total population in the considered market.

² The price responses are given by the following expression:

$$\frac{\partial s_j}{\partial p_k} = \begin{cases} (\alpha + \omega V_j)(1 - s_j) s_j & \text{for } j=k, \\ -(\alpha + \omega V_j) s_j s_k & \text{otherwise.} \end{cases}$$

stance, Yoplait Original sold in supermarket S1 is different than the Yoplait Original sold in supermarket S2. In consequence, the consumer is facing a set of 44 brands rather than 11¹.

Table 1. Descriptive statistics and characteristics of the brands in the sample

		Mean	Std.dev.	Min	Max
Weekly data	Unit sales (1000)	9.1225	18.663	206	279.86
	Dollar sales (\$1000)	9.4185	12.398	165.79	135.37
	Volume sales (1000 lb)	6.0008	8.4870	105.375	111.98
Characteristics	Sugar (g)	6.84	17.7	8	28
	Fat (g)	1.09	0.93	0	2.5
	Calories	112.68	37.32	60	160

For the multinomial logit model, equation (1) implies the endogeneity of the prices and consequently the need to use instrumental variables. The endogeneity comes from the fact that retail prices depend on product characteristics, and any variation in those characteristics will induce a variation in retail prices. The instrumental variables used should be correlated with retail prices but not correlated with market share (the dependent variable). This study uses the short-term interest rate (3 months), long-term interest rate (7 years), and gasoline price in the Houston area, interacted with brand dummy variables as retail prices instruments.

Table 2. Retail prices, market shares and variety offering of brands in the sample

	S1		S2		S3		Average	
	Price (\$/lb)	M.S. (%)	Price (\$/lb)	M.S. (%)	Price (\$/lb)	M.S. (%)	Price (\$/lb)	M.S. (%)
Dannon								
Activia	2.15	0.47	2.20	1.92	2.68	0.41	2.34	0.93
Fat Free	1.26	0.23	1.31	0.81	1.34	0.26	1.30	0.44
Light	1.36	0.23	1.31	1.37	1.56	0.66	1.41	0.76
Natural	1.23	0.24	1.22	0.63	1.26	0.20	1.24	0.36
Stonyfield								
Farm	1.63	0.06	1.96	0.50	3.18	0.02	2.26	0.19
Yobaby	2.07	0.06	2.36	0.33	2.69	0.13	2.37	0.16
Yoplait								
Go Gurt	2.13	0.55	2.14	0.74	2.27	0.14	2.18	0.47
Light	1.50	0.23	1.48	5.36	1.65	1.51	1.54	2.37
Original	1.50	1.83	1.46	5.78	1.65	1.42	1.54	3.01
Trix	1.53	0.49	1.41	0.87	1.73	0.14	1.56	0.50
Private label	1.32	0.08	1.02	7.91	1.67	0.16	1.34	2.72
Average	1.61	0.40	1.62	2.38	1.97	0.46	1.73	1.08
Average variety	23.34		24.85		16.73		21.64	

¹ 4 supermarkets with 11 brands choices in each one will generate a 44 choice set as a total.

3. Results

3.1. Demand results. The estimation results of the multinomial logit demand model for yogurt data are reported in Table 3. All parameter estimates of demand are statistically significant. As expected, the price parameter estimate is negative, indicating that consumer utility declines as the price of the yogurt brand increases. In contrast, the variety parameter estimate is positive, implying that consumer utility increases with a larger brand variety offering. However, simultaneously increasing the price and the variety offering will induce reduction in consumer utility as indicated by the negative sign of the parameter estimate of the interaction between price and variety offering. This result suggests that variety offering accentuates consumer price sensitivity.

Table 3. Parameter estimates of the multinomial logit model

Variable	Parameter	Estimate	t-value
Price	β	-2.5769	-43.3402
Variety	μ	0.0426	2.4893
Variety*Price	ω	-0.0422	-2.3022
Sugar	α_1	1.3632	25.9839
Calories	α_2	-5.1376	-38.5660
Fat	α_3	0.4057	26.4341

For the brand characteristics, the parameter estimates have different signs. The parameter estimate of calories content is a negative estimate, implying that consumers prefer to consume yogurt products with fewer calories rather than yogurt products with more calories. However, the parameter estimates of fat and sugar contents are positive, suggesting consumer preferences for higher sugar and fat content. These results show that consumers put more emphasis on taste than nutrition and health issues when choosing yogurt products. This interpretation, however, should be taken cautiously as the multinomial logit does not take into account consumer heterogeneity.

Tables 4 and 5 present the own-price elasticities implied by the multinomial logit model with and without the price-variety interaction, respectively. Notice that the demand at the brand-supermarket level is elastic whether or not the price-variety interaction is included. This is consistent with the differentiated demand estimates at the supermarket level. For example, Villas-Boas (2007) found an average own-price elasticity of -5.908 for Dannon brands. When the interaction between the price and variety is ignored, the own-price elasticities range from -4.4389 for Stonyfield Farm brand in supermarket 3 to -1.2384 for private label in supermarket 4. When the price-variety interaction is included, these own-price elasticities range from -7.0238 for Stonyfield Farm brand in supermarket 3 to -2.0296 for private label in supermarket 3. The results also show that when

variety offering is taken into account and variety offering is accompanied by higher prices, consumers become more price-sensitive. For instance, the market share of Dannon Activia will decrease by

5.7216 percent for every 1 percent increase in price when price-variety is included, while this decrease is only 3.1821 percent when price-variety interaction is not included.

Table 4. Own-price elasticity estimates without price-variety interaction

Yogurt brands	Supermarket 1	Supermarket 2	Supermarket 3	Supermarket 4	Average
<i>Dannon</i>					
Activia	-2.9951	-3.0327	-3.7319	-2.9687	-3.1821
Fat Free	-1.7599	-1.8136	-1.8757	-1.6958	-1.7863
Light	-1.9036	-1.8158	-2.1756	-1.7239	-1.9047
Natural	-1.7132	-1.6998	-1.7623	-1.6770	-1.7130
<i>Stonyfield</i>					
Farm	-2.2752	-2.7232	-4.4389	-2.3300	-2.9418
Yobaby	-2.8893	-3.2868	-3.7523	-2.7601	-3.1721
<i>Yoplait</i>					
Go Gurt	-2.9593	-2.9721	-3.1607	-2.9203	-3.0031
Light	-2.0934	-1.9964	-2.2827	-1.9053	-2.0694
Original	-2.0768	-1.9666	-2.2799	-1.8759	-2.0498
Trix	-2.1242	-1.9661	-2.4099	-2.1148	-2.1537
<i>Private label</i>	-1.8423	-1.3478	-1.2784	-1.2384	-1.4267
Average	-2.2393	-2.2383	-2.6499	-2.1100	-2.3094

Table 5. Own-price elasticity estimates with price-variety interaction

Yogurt brands	Supermarket 1	Supermarket 2	Supermarket 3	Supermarket 4	Average
<i>Dannon</i>					
Activia	-5.3689	-5.5855	-5.8756	-6.0563	-5.7216
Fat Free	-3.1560	-3.3422	-2.9548	-3.4638	-3.2292
Light	-3.4133	-3.3475	-3.4295	-3.5210	-3.4278
Natural	-3.0725	-3.1324	-2.7748	-3.4238	-3.1009
<i>Stonyfield</i>					
Farm	-4.0856	-5.0252	-7.0238	-4.7765	-5.2278
Yobaby	-5.1917	-6.0721	-5.9176	-5.6499	-5.7078
<i>Yoplait</i>					
Go Gurt	-5.3126	-5.4716	-4.9992	-5.9527	-5.4340
Light	-3.7584	-3.6762	-3.6003	-3.8947	-3.7324
Original	-3.7309	-3.6221	-3.5959	-3.8357	-3.6969
Trix	-3.8199	-3.6192	-3.8069	-4.3285	-3.8936
<i>Private label</i>	-3.3011	-2.4858	-2.0296	-2.5245	-2.5852
Average	-4.0192	-4.1254	-4.1825	-4.3116	-4.1597

All cross-price elasticities are positive as expected. The magnitude of cross-price elasticities is much lower than the magnitude of own-price elasticities. This may suggest some brand-supermarket loyalty on the part of consumers. For example, if the price of Yoplait Original increases by 10 percent, the increase in the market share of Dannon Natural is only 1.41 percent. The values of the cross-price

elasticities range from a low value of 0.0050 to a high value of 0.1099. As mentioned previously, in each supermarket, these cross-price elasticities are equal, which is expected due to the independence of irrelevant alternatives property of the multinomial logit model. Table 6 presents a sample of the cross-price elasticities across brands and supermarkets.

Table 6. Sample of cross-price elasticities

	Supermarket 1				Supermarket 2			
	Dannon Natural	Yoplait Original	Stonyfield Farm	Private Label	Dannon Natural	Yoplait Original	Stonyfield Farm	Private Label
Supermarket 1								
Dannon Natural	-3.0725	0.0443	0.0018	0.0012	0.0128	0.1409	0.1340	0.0129
Yoplait Original	0.0049	-3.7309	0.0018	0.0012	0.0128	0.1409	0.1340	0.0129
Stonyfield Farm	0.0049	0.0443	-5.1917	0.0012	0.0128	0.1409	0.1340	0.0129
Private label	0.0049	0.0443	0.0018	-3.3011	0.0128	0.1409	0.1340	0.0129

Table 6 (cont.). Sample of cross-price elasticities

	Supermarket 1				Supermarket 2			
	Dannon Natural	Yoplait Original	Stonyfield Farm	Private Label	Dannon Natural	Yoplait Original	Stonyfield Farm	Private Label
Supermarket 2								
Dannon Natural	0.0050	0.0455	0.0018	0.0013	-3.1324	0.1446	0.1376	0.0132
Yoplait Original	0.0050	0.0455	0.0018	0.0013	0.0131	-3.6221	0.1376	0.0132
Stonyfield Farm	0.0050	0.0455	0.0018	0.0013	0.0131	0.1446	-6.0721	0.0132
Private label	0.0050	0.0455	0.0018	0.0013	0.0131	0.1446	0.1376	-2.4858

The results for the market share elasticity with respect to variety offering are given in Table 7. The results show that on average, an increase in variety offering will increase consumer utility and therefore brand market shares. However, variety offering has a negative effect on some brands' market shares, as for Dannon Natural in supermarket chains 1 and 3.

This is probably due to the price-variety effect. The values of the variety elasticities range from -0.3174 for the private label to 0.4101 for Stonyfield Farm in supermarket chain 3. In supermarket chains 1 and 3, consumers prefer to buy more Dannon Activia as the variety offering increases, as opposed to supermarket chains 2 and 4, where they prefer to buy less.

Table 7. The multinomial logit model variety elasticities estimates

Yogurt brands	Supermarket 1	Supermarket 2	Supermarket 3	Supermarket 4	Average
<i>Dannon</i>					
Activia	0.0111	-0.0145	0.2784	-0.0951	0.0450
Fat Free	-0.0151	0.0198	-0.1659	0.1937	0.0081
Light	-0.0118	0.0183	-0.0954	0.1846	0.0239
Natural	-0.0163	0.0232	-0.1919	0.1998	0.0037
<i>Stonyfield</i>					
Farm	-0.0106	-0.0144	0.4101	0.0310	0.1040
Yobaby	-0.0036	-0.0394	0.2723	-0.0619	0.0419
<i>Yoplait</i>					
Go Gurt	0.0027	-0.0095	0.1185	-0.0786	0.0083
Light	-0.0130	0.0144	-0.0686	0.1295	0.0156
Original	-0.0147	0.0146	-0.0697	0.1255	0.0140
Trix	-0.0185	0.0192	-0.0503	0.0863	0.0092
<i>Private label</i>	-0.0109	0.0192	-0.3174	0.2877	-0.0030
Average	-0.0091	0.0032	0.0438	0.0715	0.0274

3.2. Supply results. Table 8 gives the price-cost margins in \$/lb and the Lerner index of yogurt with and without price-variety interaction, respectively. As noted in the demand results section, the PCMs without price-variety interaction are overestimated. These PCMs average is \$0.67/lb and \$0.3680/lb, respectively. The difference across supermarket chains and manufacturer brands is not statistically significant (under a t-test). However, the Lerner index is a better indicator as it is a unitless concept; that is the PCMs as a percentage of the retail prices.

The Lerner index results indicate that ignoring price-variety interaction will result in overestimating the percentage mark-up. On average, the Lerner index is 43.73 percent when the price-variety interaction is ignored; while it averages only 23.38 percent when the price-variety interaction is included. This suggests that for each consumer dollar spent on yogurt, supermarket chains get 43.73 cents and 23.38 cents, respectively. In both cases, the Lerner index is between 0 and 1 suggesting that the indus-

try has neither perfect competition structure nor a monopoly structure. The market for yogurt at the supermarket chain level in the Houston metropolitan area is an oligopolistic market.

In addition, supermarket chains exercise some market power when selling yogurt products. Compared to the results found by Villas-Boas (2007), the results implied by the model with price-variety interaction are more consistent. Villas-Boas (2007) found that the percentage price-cost margins average 21.10 percent, and the results of this study estimate 23.38 percent for the percentage price-cost margins.

Unlike the PCMs, the Lerner index is statistically different across brands but not statistically different across supermarket chains (under a t-test). These results indicate that retailers make more money selling their own private labels than selling manufacturers brands, which conforms to theory (Tirole, 2003, p. 80). For example, the percentage mark-up of the private label in supermarket chain 2 is 35.64 percent, while it is only 16.44 for Dannon Activia. Further-

more, supermarket chains make more money, on average, selling Dannon brands than selling Yoplait or Stonyfield brands. On Dannon brands, supermarket

chains average 25.36 percent mark-up; while the percentages are 22.47 and 17.41 for Yoplait and Stonyfield brands, respectively.

Table 8. Price-cost margins and Lerner index

	Supermarket 1		Supermarket 2		Supermarket 3		Supermarket 4	
	w/o variety	w/ variety	w/o variety	w/ variety	w/o variety	w/ variety	w/o variety	w/ variety
Price-cost margins in \$/lb								
<i>Dannon</i>								
Activia	0.6727	0.6727	0.6727	0.6727	0.6718	0.6718	0.6723	0.6723
Fat Free	0.6715	0.6715	0.6723	0.6723	0.6727	0.6727	0.6714	0.6714
Light	0.6748	0.6748	0.6739	0.6739	0.674	0.674	0.674	0.674
Natural	0.6715	0.6715	0.6719	0.6719	0.6717	0.6717	0.6717	0.6717
<i>Stonyfield</i>								
Farm	0.6754	0.6754	0.6723	0.6723	0.671	0.671	0.6739	0.6739
Yobaby	0.6707	0.6707	0.6711	0.6711	0.6708	0.6708	0.6714	0.6714
<i>Yoplait</i>								
Go Gurt	0.6724	0.6724	0.6735	0.6735	0.6747	0.6747	0.6731	0.6731
Light	0.679	0.679	0.6736	0.6736	0.6747	0.6747	0.6744	0.6744
Original	0.6778	0.6778	0.6733	0.6733	0.6737	0.6737	0.676	0.676
Trix	0.6727	0.6727	0.6735	0.6735	0.6736	0.6736	0.6725	0.6725
Store Brand								
Private label	0.6734	0.6734	0.6735	0.6735	0.6734	0.6734	0.6736	0.6736
Average	0.6738	0.6738	0.6729	0.6729	0.6729	0.6729	0.6731	0.6731
Lerner index								
<i>Dannon</i>								
Activia	0.3129	0.1706	0.3061	0.1644	0.2509	0.1484	0.3131	0.1583
Fat Free	0.5324	0.2907	0.5151	0.2772	0.5004	0.2969	0.5503	0.2785
Light	0.4947	0.2714	0.5138	0.2771	0.4307	0.2553	0.5406	0.2752
Natural	0.5469	0.2988	0.5501	0.2961	0.5325	0.3158	0.557	0.2826
<i>Stonyfield</i>								
Farm	0.4146	0.2284	0.3437	0.1849	0.211	0.1243	0.4018	0.2053
Yobaby	0.3242	0.1771	0.2845	0.153	0.2496	0.1476	0.3387	0.1719
<i>Yoplait</i>								
Go Gurt	0.3163	0.1732	0.3152	0.1698	0.2977	0.1766	0.3188	0.162
Light	0.4526	0.2479	0.4547	0.2444	0.4089	0.242	0.4809	0.2441
Original	0.4507	0.2471	0.4601	0.2476	0.409	0.2422	0.4805	0.2444
Trix	0.4408	0.2416	0.4761	0.2568	0.3899	0.2313	0.44	0.2242
Store brand								
Private label	0.5107	0.2807	0.6614	0.3564	0.7266	0.4313	0.7339	0.3736
Average	0.4361	0.2389	0.4437	0.2389	0.4006	0.2374	0.4687	0.2382

Having calculated the price cost margin for each brand at each supermarket, we can recover the marginal cost for each brand at each supermarket using equation (10). Table 9 presents the retail prices and the recovered marginal cost for yogurt brands with price-variety interaction. On average, the results indicate that the marginal cost (wholesale and dis-

tribution costs combined) is \$1.2984/lb. At the brand level, the private label yogurt is the least expensive to produce and distribute, which conforms to the theory of private labeling. In addition, Dannon brands have the lowest marginal cost among manufacturers' brands, with \$1.1769/lb; followed by Yoplait brands then Stonyfield brands.

Table 9. Prices (\$/lb) and recovered marginal cost (MC, in \$/lb)

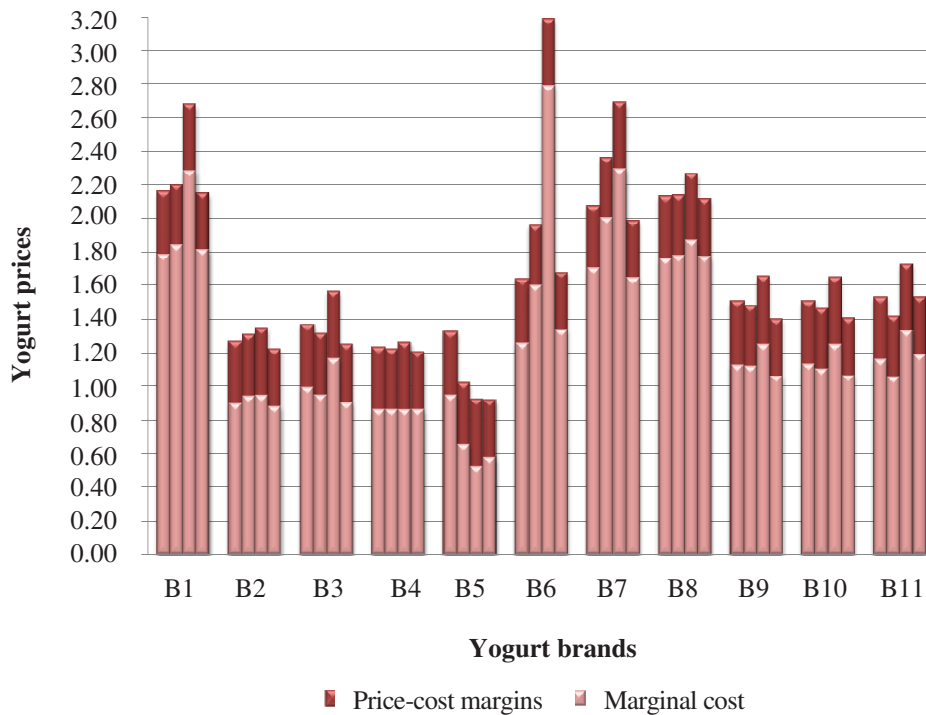
Brands	Supermarket 1		Supermarket 2		Supermarket 3		Supermarket 4		Average	
	Price	MC	Price	MC	Price	MC	Price	MC	Price	MC
<i>Dannon</i>										
Activia	2.1496	1.7829	2.1980	1.8367	2.6771	2.2799	2.1475	1.8076	2.1531	2.0970
Fat Free	1.2612	0.8945	1.3050	0.9433	1.3445	0.9454	1.2200	0.8802	1.1306	1.0440
Light	1.3641	0.9939	1.3115	0.9481	1.5638	1.1645	1.2468	0.9037	1.2275	1.1357
Natural	1.2277	0.8909	1.2215	0.8598	1.2624	0.8637	1.2059	0.8651	1.0717	1.0016

Table 9 (cont.). Prices (\$/lb) and recovered marginal cost (MC, in \$/lb)

Brands	Supermarket 1		Supermarket 2		Supermarket 3		Supermarket 4		Average	
	Price	MC	Price	MC	Price	MC	Price	MC	Price	MC
<i>Stonyfield</i>										
Farm	1.6292	1.2570	1.9560	1.5943	3.1808	2.7855	1.6771	1.3329	2.0114	1.9517
Yobaby	2.0690	1.7026	2.3589	1.9980	2.6879	2.2911	1.9824	1.6416	2.1557	2.0177
<i>Yoplait</i>										
Go Gurt	2.1258	1.7576	2.1368	1.7740	2.2663	1.8661	2.1115	1.7694	2.0054	1.9381
Light	1.5002	1.1282	1.4814	1.1194	1.6501	1.2507	1.4022	1.0600	1.3617	1.2687
Original	1.5041	1.1325	1.4634	1.1011	1.6470	1.2481	1.4068	1.0629	1.3576	1.2689
Trix	1.5260	1.1573	1.4147	1.0514	1.7274	1.3278	1.5286	1.1859	1.3905	1.3582
<i>Private label</i>	1.3185	0.9485	1.0183	0.6554	0.9269	0.5271	0.9178	0.5749	0.9018	0.7304
Average	1.6069	1.2378	1.6242	1.2619	1.9031	1.5045	1.5315	1.1895	1.5243	1.4375

At the supermarket level, the difference between marginal costs is statistically significant. Supermarket chain 1, serving mainly Hispanic consumers, has the lowest marginal cost among traditional supermarket chains with an average of \$1.2378/lb. Figure 2 gives the decomposition of retail prices in price-cost margins and marginal cost. On average, the marginal cost represents more than 77 percent of the retail prices, the remainder being the percentage

mark-up as previously mentioned. For private labels, this percentage is about 62 percent of the retail price. This again suggests that for retailers it is more profitable to sell their own brands and carry fewer national brands or carry national brands with slotting allowances (Bloom et al., 2003) (slotting allowances are fees paid by manufacturers to supermarket chains for shelf space for a new product; also referred to as the stocking allowance).



Notes: B1: Dannon Activia; B2: Dannon Fat Free; B3: Dannon Light; B4: Dannon Natural; B5: Stonyfield Farm; B6: Stonyfield Yobaby; B7: Yoplait Go Gurt; B8: Yoplait light; B9: Yoplait Original; B10: Yoplait Trix; and B11: Private label.

Fig. 2. Retail prices, price-cost margins and marginal costs

Conclusions

This study estimates the effect of variety offering on consumer demand and supermarket chain profit, using the multinomial logit demand model. Using IRI data from four supermarket chains sales in the Houston metropolitan area, the study estimates the demand for different yogurt brands at the brand-supermarket

level. The variety offering is modeled as an intercept as well as a shifter of the price parameter in consumer utility (price-variety interaction). Using the multinomial logit demand model results, the study computes price-cost margins at the brand-supermarket level and assesses the effect of variety offering on these margins and competition in this particular market.

With respect to demand, the results show that variety offering positively shifts the consumer utility, meaning that consumers are more likely to purchase a certain yogurt brand if the variety offering of that brand increases. However, when price-variety interaction is included, not all the own-variety elasticity estimates are negative and not all the cross-variety elasticities are positive.

In addition, consumer price sensitivity increases as we take into account the variety offering. The magnitude of the own-price elasticity increases as the price-variety interaction is included in the indirect utility. Therefore, ignoring this interaction would yield underestimated (in absolute value) elasticities and consequently overestimated price-cost margins.

With respect to supply, the results indicate that supermarket chains exercise some degree of market power when selling yogurt products. However, the degree of market power is reduced as more variety is offered, mainly because of an increase in marginal cost and consumer price sensitivity. In addition, the results suggest that supermarket chains make more money selling their own brands. This creates a conflict for the supermarket chains. On one hand, consumers want greater variety, forcing the retailer to offer more national brands. On the other hand, increasing variety raises retailers' marginal cost and ultimately retail prices, which in turn can affect demand.

The results shed light on various aspects that are relevant for researchers, policy makers, and retailers. For the researchers, the results show that the variety offering affects consumers' utility and retailers' performance and therefore should not be ignored in modeling consumers' and retailers' behavior. On the other hand, the results can be used by the retailers as a management tool. The findings show that the demand for all the brand/supermarket considered is elastic. This implies that a small change in the price will induce a bigger change in the sales. For the policy makers, the results show the supermarket chains in Houston have some market power in setting retail prices for yogurt brands.

However, the paper presents at least two potential limitations. First, the consumer heterogeneity is not taken into account. It is well documented (Berry et al., 1995; Nevo, 2001; Villas-Boas, 2007; and Chidmi and Lopez, 2007) that besides product's attributes, consumer's characteristics play an important role in demand analysis. In fact, the price sensitivity depends on consumer's observed (demographics) and unobserved (to the researcher) characteristics. Second, it is more realistic to think that retailers set the retail prices as well as the number of items to be sold (variety). Therefore, the variety offering should be treated as an endogenous variable instead of an exogenous variable.

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