Estimating Demand for Differentiated Eggs Using Scanner Data

Yan Heng

Department of Agricultural Economics

Kansas State University

yheng@ksu.edu

Hikaru Peterson

Department of Agricultural Economics

Kansas State University

hhp@ksu.edu

Selected paper prepared for presentation at the Agricultural & Applied Economics Association's 2014 AAEA Annual Meeting, Minneapolis, MN, July 27-29, 2014

Introduction

In the food markets, consumers' increasing concern about food safety, health benefits, animal welfare, and environmental impact has boosted the demand for differentiated agricultural products, such as organic, nutrient-enhanced, and animal-friendly varieties. Grocery stores have provided consumers with increasingly more product choices differentiated by brand, color, size, packaging, and production methods. Studying the demand and price elasticities of differentiated products is critical for examining firms' strategies and impacts on a given product market as well as for improving our understanding of consumer shopping behavior.

Two data sources are used to examine consumers' preferences and demand for differentiated products: stated and revealed preference data. The advantage of utilizing stated preferences is that hypothetical choices allow for researchers to study products that are not sold in the market (i.e., new products). However, stated preference data have been criticized for their reliability since respondents typically make different purchasing decisions in reality from their stated outcomes in hypothesis settings. Also, many influential factors, such as budget constraints and store discounts, are generally ignored in choice experiments, which could cause an upward bias of estimated demand. As an alternative, revealed preferences, such as scanner data, reflect consumers' real purchased choices in the markets and are able to capture consumer's dynamic behavior by recording their purchases over time (Swait and Andrew, 2003; Chang, Lusk, and Norwood, 2009).

A major problem with estimating demand for differentiated products using real market data is the dimensionality problem. The number of parameters to be estimated increases exponentially as the number of products increases. Traditional demand approaches that use product-space concept, such as AIDS and Rotterdam models, attempt to solve the dimensionality problem by aggregating individual products (e.g., Lusk, 2010; Anders and Moeser, 2008) and using multi-budgeting to group products into a reduced number of categories (e.g., Hausman, Leonar, and Zona, 1994). However, both methods require prior groupings and assumptions of product relationships within categories, which are subjective and may yield inconsistent results due to researchers' different opinions on grouping. For example, cross price elasticity between two brands from different groups will be lower than the one between brands in the same group. Another issue with traditional demand methods is the use of a "representative" consumer, which does not allow for consumer heterogeneity in the model (Lianos and Genakos, 2012).

A flexible model that claims to overcome the shortcomings of the traditional demand models is the random coefficient logit model developed by Berry, Levinsohn, and Pakes (1995; henceforth BLP). The BLP model allows for substitution patterns based on product attributes and consumer characteristics without a priori product grouping, and the model also accounts for potential endogeneity of product prices. The BLP model has been applied to various markets including automobiles (Berry, Levinsohn, and Pakes, 1995), breakfast cereals (Nevo, 2000a, 2001), milk (Lopez and Lopez, 2009), and apples (Richards, Acharya, and Molina, 2011). In addition to the prominent papers using the BLP model, Nevo published an "A Practitioners' Guide" for the BLP implementation and made his code available online for public, which has become heavily cited (Nevo, 2000b). In this paper, we apply the BLP model to the case of differentiated eggs and study the substitution patterns between conventional and specialty products, as well as those among different specialty eggs.

As a relatively cheap source of protein and minerals, the annual consumption of eggs in the U.S. has been stable at approximately 250 eggs per person since late 1990s (USDA, 2013). To meet consumers' specific demands, the production of specialty eggs has increased steadily and accounted for nearly 16% of the entire egg market in 2005 (Chang, Lusk, and Norwood, 2010). The sales of organic, omega-3 and vegetarian eggs contributed 5.6% of the industry revenue in 2013, while cage-free eggs accounted for 4.3% (IBISWorld, 2014).

Previous studies have offered insights into consumers' preferences and demands on differentiated eggs. Based on stated preference surveys, Asselin (2005) reported that Canadian consumers were willing to pay a premium up to $0.72/dozen for omega-3 eggs, depending on their health consciousness; Heng, Peterson, and Li (2013) found that most subjects in their U.S. study were willing to pay a positive premium for organic eggs as well as for eggs produced under animal welfare friendly environment. Using scanner data, Lusk (2010) estimated an Almost Ideal Demand System (AIDS) model to examine the effect of Proposition 2 in California and found that demand for cage-free and organic eggs increased over time in Francisco and Oakland, while demand in Dallas was unchanged; Chang, Lusk, and Norwood (2010) estimated a hedonic pricing model to find that average consumers valued cage-free, organic, and omega-3 eggs, but the observed premium for cage-free eggs was attributed to shell color.

The objective of this study is to estimate demand relationships in the U.S. differentiated egg market using scanner data. A BLP random coefficient logit model will be used to overcome the dimensionality problem and account for consumer heterogeneity, while an AIDS model will also be estimated as a baseline for comparison. Despite the shortcomings of traditional demand models as discussed above, AIDS model has been applied and accepted widely in the literature. The comparison of estimated results from BLP and AIDS models with the same dataset would help illustrate the limitations and opportunities with the two approaches in demand analysis of differentiated products.

The brand-level scanner data on national egg sales from 2008 to 2010 from Nielsen include over 300 brands (including specific and private brands) with 2,287 products that are differentiated by size, package size, shell color, and labeled attributes, such as organic, omega-3, and hormone-free. Information on consumer characteristics (household income and number of children under 18 years old) will be used to model consumers' taste. Although we do not directly observe consumer characteristics from the Nielsen data, we will estimate the distribution of the demographics based on a large sample, such as the Current Population Survey. The estimated parameters will be used to calculate own- and cross-price elasticities at a product level. Conceptually, we suppose that firms produce some subset of observed differentiated products to maximize total profits on the supply side. Under the assumption of a Bertrand-Nash equilibrium, the first-order condition of the profit maximization problem will yield the marginal cost, which can be further used to calculate markup. Such results will provide a more complete picture of price competition in the market.

Our preliminary results show that average consumers exhibit an overall preference for conventional eggs. Higher earning households and those with more children under 18 years old tend to value organic and additive-free eggs more than others. Conventional and private label eggs have lower own-price elasticities, which indicates average consumers for such egg products are less price sensitive. Specialty and manufacture brand eggs tend to yield lower margin due to higher marginal costs, which is consistent with previous findings that basic products are associated with greatest price-cost margins (Chidmi and Lopez, 2007).

Models

The AIDS Model

The AIDS model was introduced by Deaton and Muellbauer in 1980 and has become one of the most widely used demand models. This model is still a dominant choice in applied demand analysis, although it suffers from several shortcomings as a classical product space approach discussed above. Start with an expenditure function which defines the minimum expenditure necessary on a set of products *I* to attain a level of utility at given prices:

$$logc(u,p) = \alpha_0 + \sum_{i \in I} \alpha_i logp_i + \frac{1}{2} \sum_{i \in I} \sum_{j \in I, j \neq i} \gamma_{ij} logp_i logp_j + u\beta_0 \prod_i p_i^{\beta_i} \quad (1)$$

where α_i, β_i, and γ_{ij} are parameters, p_i is the product price, and u is the utility level.

The demand functions can be derived from the expenditure function using Shepard's Lemma. The budget share can be expressed as:

$$w_i = \alpha_i + \sum_j \gamma_{ij} logp_j + \beta_i log(X/P) \quad (2)$$

where $X(= \sum_i p_i q_i)$ is the total expenditure on all products in the segment, w_i $(= \frac{p_i q_i}{X})$ is the expenditure share of product *i* , and *P* is a nonlinear price index defined by:

$$\log(P) = \alpha_0 + \sum_i \alpha_i \log p_i + \frac{1}{2} \sum_i \sum_j \gamma_{ij} logp_i logp_j \quad (3)$$

Three restrictions are imposed to be consistent with theory:

Adding-up: $\sum_i \alpha_i = 1, \sum_i \gamma_{ij} = 0, \sum_i \beta_i = 0;$

Homogeneity: $\sum_j \gamma_{ij} = 0;$

Symmetry: $\gamma_{ij} = \gamma_{ji}$ (4)

According to Green and Alston (1990), the price elasticities of the AIDS model can be derived as follows:

$$e_{ij}^* = -\delta_{ij} + \left(\frac{\gamma_{ij}}{w_i}\right) - \left(\frac{\beta_i}{w_i}\right)(\alpha_j - \sum_k \gamma_{kj} logp_k) \quad (5)$$

where δ_{ij}=1 if $i = j$ for own-price elasticities, and $\delta_{ij} = 0 \ if \ i \neq j$ for cross-price elasticities.

The Random Coefficient Logit Model (BLP)

In a random coefficient logit model, consumers are assumed to purchase the product that give them the highest utility. The indirect utility of consumer *i* of choosing product *j* can be specified as:

$$U_{ij} = \boldsymbol{x_j \beta_i} - \alpha_i p_j + \xi_j + \varepsilon_{ij} \tag{6}$$

where x_j, p_j, and ξ_j are observed product characteristics, product price, and unobserved product characteristics; β_i and α_i are parameters that represent individual taste and marginal utility of price, and ε_{ij} represents a random component across consumers and choices.

The individual-specific parameters β_i and α_i can be decomposed into a mean value, a taste component varied with observed demographics, and a taste component varied with unobserved consumer characteristics as:

$$\binom{\alpha_i}{\boldsymbol{\beta_i}} = \binom{\alpha}{\boldsymbol{\beta}} + \boldsymbol{\Gamma D_i} + \boldsymbol{\Sigma \nu_i} \tag{7}$$

where $\binom{\alpha}{\boldsymbol{\beta}}$ capture the mean levels, $\boldsymbol{D_i}$ is a vector of demographic variables with a distribution from other data sources, $\boldsymbol{\nu_i}$ is a vector that capture unobserved consumer characteristics that is usually assumed to follow a normal distribution. $\boldsymbol{\Gamma}$ and $\boldsymbol{\Sigma}$ are matrices of parameters that measure the taste vary with demographics and unobserved characteristics (i.e, whether the individual owns a dog). Now, the mean utility level (δ_{ij}) can be expressed as:

$$\delta_{ij} = \boldsymbol{x_j \beta} - \alpha \, p_j + \xi_j \tag{8}$$

The demand system is completed with an outside good, which represents consumers' options outside of the dataset. For an outside good, the mean level of utility, δ_0, is normalized to equal zero.

If we let $\boldsymbol{\theta} = (\boldsymbol{\Gamma}, \boldsymbol{\Sigma})$ be a vector of non-linear parameters, the variation from the interaction of consumer *i*'s characteristics and product *j*'s attributes can be captured by:

$$\mu_{ij}(\boldsymbol{x_j}, p_j, \boldsymbol{\nu_i}, \boldsymbol{D_i}; \boldsymbol{\theta}) = (-p_j, \boldsymbol{x_j})(\boldsymbol{\Gamma D_i} + \boldsymbol{\Sigma \nu_i}) \tag{9}$$

The indirect utility function can now be written as a summation of three terms:

$$U_{ij} = \delta_{ij} + \mu_{ij} + \varepsilon_{ij} \tag{10}$$

where $\mu_{ij} + \varepsilon_{ij}$ represent a deviation from the mean utility with a zero mean.

If an individual who chooses product *j* can be defined by a vector of consumer characteristics and product-specific shocks:

$$A_j\left(\boldsymbol{\nu_i}, \boldsymbol{D_i}, \varepsilon_{i0}, \dots \varepsilon_{iJ}\right) = \left\{\left(\boldsymbol{\nu_i}, \boldsymbol{D_i}, \varepsilon_{i0}, \dots \varepsilon_{iJ}\right) | U_{ij} \geq U_{il} \;\; \forall l = 0,1, \dots, J\right\} \quad (11)$$

The predicted market share of product *j* is an integral over the mass of consumers in the region A_j, which can be expressed as:

$$s_j\left(\boldsymbol{x_j}, p_j, \alpha, \boldsymbol{\beta}, \boldsymbol{\theta}\right) = \int_{A_j} d\boldsymbol{F}(\boldsymbol{\upsilon}, \boldsymbol{D}, \boldsymbol{\varepsilon}) = \int_{A_j} d\boldsymbol{F}(\boldsymbol{\nu})\, d\boldsymbol{F}(\boldsymbol{D}) d\boldsymbol{F}(\boldsymbol{\varepsilon}) \quad (12)$$

Assuming that ε_{ij} is an iid error with an extreme value type I density, the equation (15) becomes:

$$s_j\left(\boldsymbol{x_j}, p_j, \alpha, \boldsymbol{\beta}, \boldsymbol{\theta}\right) = \int_{A_j} \frac{e^{\delta_{ij}+\mu_{ij}}}{1+\sum e^{\delta_{il}+\mu_{il}}} d\boldsymbol{F}(\boldsymbol{\nu})\, d\boldsymbol{F}(\boldsymbol{D}) \quad (13)$$

The uncompensated price elasticities are defined as:

$$\eta_{jk} = \frac{ds_j}{dp_k}\frac{p_k}{s_j} = \begin{cases} -\frac{p_j}{s_j}\int \alpha_i s_{ij}\left(1 - s_{ij}\right) d\boldsymbol{P}(\boldsymbol{D}) d\boldsymbol{P}(\boldsymbol{\nu}) \;\; if\ j = k \\ \;\; \frac{p_j}{s_j}\int \alpha_i s_{ij} s_{ik} d\boldsymbol{P}(\boldsymbol{D}) d\boldsymbol{P}(\boldsymbol{\nu}) \;\;\; otherise \end{cases} \quad (14)$$

where $s_{ij} = \frac{e^{\delta_{ij}+\mu_{ij}}}{1+\sum e^{\delta_{il}+\mu_{il}}}$ is the probability of individual *i* purchasing product *j*. This expression for elasticities is more difficult to compute than the one computed with AIDS model in equation (9). The difficulty comes from the integrals, which need to be calculated by simulation.

Supply Side

With respect to the supply side, following Nevo (2010a) we assume that there are F multi-product producers, and each of them produces some subset J_f of the *J* products. They choose the range of prices for the J_f differentiated products to maximize total profits, that is:

$$\Pi_f = \sum_{j \in J_f} (p_j - c_j) s_j M \quad (15)$$

where p_j is product *j*'s price, c_j is the marginal cost, s_j is the market share, and M is the number of consumers in the market. Under the assumption of Bertrand-Nash equilibrium, the first-order condition for product *j* is given by:

$$s_j + \sum_{k \in J_f} (p_k - c_k) \frac{\partial s_k}{\partial p_j} = 0 \tag{16}$$

In vector notation, the first-order condition for J_f products can be rewritten as:

$$\boldsymbol{s} + \boldsymbol{\Omega} \frac{\partial \boldsymbol{s}}{\partial \boldsymbol{p}} (\boldsymbol{p} - \boldsymbol{c}) = 0 \tag{17}$$

where $\boldsymbol{\Omega}=\mathbf{1}$ if product *j* and *k* are sold by the same firm and $\boldsymbol{\Omega}=\mathbf{0}$ otherwise. As prices and the market shares are observed, the marginal cost can be calculated at a product level.

Data and Estimation

Egg sales and consumer characteristics are the two sets of data used for the empirical demand estimation. Instrumental variables are used to address the potential price endogenous problem. The egg sales data are provided by Nielson. The data include weekly sales of over 300 brands encompassing 2,287 products nationwide from April, 2008 to March, 2010. Observed product characteristics include brand name (private labels and specific brands), egg size, package size, shell color, and labeled attributes, such as organic, nutrient-enhanced (including omega-3 and vitamin-added), and additive-free.

Since consumer characteristics and instrumental variables are reported monthly, the weekly egg sale data are aggregated into 23 months, and each month was treated as a market. Retail prices are computed by dividing the dollar sales of each product by volume sold. Market shares for each product are computed based on the potential market for eggs, which was defined by the total monthly U.S. egg consumption. Thus, the outside good is defined as the part of the potential market that is not included in the sample. After dropping products with less than 0.05% market share of the potential market, a total of 30 products with eight brands are generated as described by five characteristics: organic, nutrient-enhanced, additive-free, brown shell, and conventional eggs. For AIDS model estimation, we aggregated individual products into these five categories. When the products fit into more than one category, the listed order of characteristics was used to determine the category it belonged. For example, a product of organic, brown eggs was categorized as “organic”, as was organic, omega-3 eggs,

Monthly information on consumer characteristics (household income and number of children under 18 years old) was obtained from the Current Population Survey (U.S. Bureau of the Census). For each month, characteristics of 500 individuals were randomly drawn to match the egg purchases in the market. Unobservable characteristics were generated from a standard normal distribution.

The parameters were computed by minimizing the distance between predicted and observed market shares using the generalized method of moments (GMM). The instrumental variables address the potential price endogenous problem. Following Villas-Boas (2007) and Lopez and Lopez (2009), instrumental variables include the interactions of eight brand dummies with input prices (price of feed: corn and soybean, and electricity), which in total result in 24 instrumental variables. The prices of corn and soybean came from the Feed Grains Database (U.S. Department of Agriculture). For the price of electricity, the Consumer Price Index (CPI) reported by the Bureau of Labor Statistics was used.

Results

Preliminary results for the BLP model were obtained from STATA (Vincent, 2012) and are reported in Table 1. The taste parameters for mean utility in the BLP model are displayed, as well the deviations from the mean depending on consumer characteristics, including log of income and number of children under 18 years old, in adjacent columns. Note that most of the estimated coefficients and deviations are not statistically significant. As expected, the coefficient for price is negative and statistically significant, implying that higher prices generate disutility for consumers. Consumers also show preference for larger packages of eggs. On average, consumers have an overall preference for conventional eggs over specialty eggs, including organic, nutrient, additive-free, and brown shell. Regarding taste heterogeneity, the higher income households and households with more children under 18 years old have greater preferences for organic and additive-free eggs, but lower preference for nutrient-enhanced eggs.

Own- and cross- price elasticities at product level were computed to examine the demand substitution patterns among egg products. There are a total of 900 own- and cross-prices elasticities (30×30) for 30 products in each market, and Table 2 presents price elasticities for selected 15 products in market due to the page space limit. These selected products involve private label and manufactured brands, conventional and specialty egg products.

As expected, all the own-price elasticitities are negative, varying from -1.37 to -4.86. In general, demand for private label products were less elastic, which indicates private label egg consumers are less price sensitive to price changes. Such results are consistent with previous findings regarding private label (Cotterill and Samson, 2002; Lopez and Lopez, 2009), and this may be because private label products are almost always cheaper, as Cotterill and Samson (2002) claimed. With respect to manufacturer brands, products from Land O'Lakes seem more elastic than those from other brands. Also, specialty eggs have higher own-price elasticities, suggesting consumers are more price sensitive to their price changes. For example, within private label products, the own-price demand elasticities of conventional eggs were as low as -1.87 but became -2.61 for nutrient-enhanced eggs and -3.05 for organic eggs. Organic egg products with brown shell are the most price sensitive, although such products are always higher priced than other eggs.

Table 2 also presents all cross-price elasticities, which range from 0 to 2.72. In general, conventional eggs under private labels tend to substitute with each other, while conventional egg shoppers of other brands tend to shift toward conventional eggs under private labels when prices increase in other brands. When the price of nutrient-enhanced eggs increase, consumers tend to substitute with conventional eggs under private label. This result may indicate that nutrient-enhanced egg shoppers do not value such attributes as robust as other specialty egg shoppers. One interesting finding is that organic egg shoppers not only substitute with another organic egg product, but also substitute with brown shell eggs when prices for organic eggs increase. Also, some brown egg shoppers of manufacture brand would substitute with other brown eggs as well as organic and nutrient-enhanced eggs. Such results may suggest that consumers value brown shell as a sign of higher health benefit, since functional eggs are usually with brown shell.

The estimated price elasticities were compared to the results generated from the AIDS model, which is displayed in Table 3. With the same dataset of the weekly egg sales nationwide, the AIDS model yields somewhat implausible cross-price elasticites with some cross-price elasticitites that are negative. For example, organic and additive-free eggs appear to be compliments. Such results are not unique to our dataset; using the data for the cereal market, Hausman (1996) and Nevo (1997) also found that AIDS model yielded negative cross-price elasticities among differentiated products.

Using the estimated results from the BLP model, product-level marginal costs are recovered by assuming a Nash-Bertrand equilibrium. Predicted marginal costs for all 30 selected egg products are displayed in Table 4. In general, thanks to lower marginal costs, private label egg products yield higher margins than manufacturer brand eggs, and conventional products yield higher margins than specialty eggs. Such results are consistent with previous finding that basic types of products had higher markups (Chidmi and Lopez, 2007; Lopez and Lopez, 2009). For example, among private labeled products, a dozen pack of medium organic eggs sells for almost twice the price of a dozen pack of medium conventional eggs, but its margin is nearly 40% lower than the conventional eggs due to much its higher marginal cost.

Conclusion

This study applied a random coefficient logit (BLP) model to estimate the demand and price elasticities for the egg industry, and an AIDS model was also estimated for a comparison purpose. Our results show that average consumers prefer larger packages and conventional eggs. Higher income level households and those with more children under 18 years old tend to value organic and additive-free eggs more than others. Conventional and private label eggs have lower own-price elasticities. The substitution pattern among brown shell eggs and organic as well as nutrient-enhanced eggs suggests consumers are likely perceiving brown shells as a signal of higher health benefit.

Specialty and manufacture brand eggs yielded lower margins due to higher marginal costs. Such results indicate that even though specialty eggs usually have higher prices, but lower margin and high own-elasticities may cause market share losses for specialty egg producers when their prices increase, which are usually due to higher input prices. In sum, private label and conventional eggs still attract average consumers, and their producers are also able to earn higher margins due to lower marginal costs in the market.

With an empirical comparison of AIDS and BLP models using the same egg dataset, the AIDS model generated seemingly implausible cross-price elasticities compared with the BLP model, but additional studies in other markets are needed to verify this results.

References

Asselin, A. M. (2005). "Eggcentric Behavior—Consumer Characteristics That Demonstrate Greater Willingness to Pay for Functionality." *American Journal of Agricultural Economics*, *87*(5), 1339-1344.

Berry, S (1994), "The Pure Characteristics Demand Model," International Economic Review, 48 (4).

Berry, S., Levinsohn, J., & Pakes, A. (1995)." Automobile Prices in Market Equilibrium. *Econometrica: Journal of the Econometric Society*, 841-890.

Berry, S and Pakes, A (2007), "The Pure Characteristics Demand Model," International Economic Review, 48 (4).

Chang, J. B., Lusk, J. L., & Norwood, F.B (2010). "The Price of Happy Hens: A Hedonic Analysis of Retail Egg Prices. *Journal of Agricultural and Resource Economics*, *35*(3), 406.

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

Heng, Y., Peterson, H. H., & Li, X. (2013). "Consumer Attitudes toward Farm-Animal Welfare: The Case of Laying Hens." *Journal of Agricultural and Resource Economics*, *38*(3), 418-434.

Hausman, J.A. (1996). "Valuation of New Goods under Perfect and Imperfect Competition", In T. F. Bresnahan and R. Gordon (eds). *The Economics of New Goods*. Chicago: National Bureau of Economic Research.

Hausman,J., G. Leonard, and J.D. Zona (1994), "Competitive Analysis with Differentiated Products," Annales D'Economie et de Statistique, 34, 159-180.

Huang, D., C. Rojas and F. Bass (2008), "What Happens when Demand is Estimated with a Misspecified Model?" Journal of Industrial Economics, 56, 8 9-39.

IBSWorld. 2014. "US Industry Reports (NAICS): Chicken Egg Production." Available online: http://clients1.ibisworld.com/reports/us/industry/productsandmarkets.aspx?entid=54

Lianos, I., & Genakos, C. (2012). "Econometric Evidence in EU Competition Law: An Empirical and Theoretical Analysis." *CLES Research Paper series*, *6*, 12.

Lopez, E., & Lopez, R. A. (2009). "Demand for Differentiated Milk Products: Implications for Price Competition." *Agribusiness*, *25*(4), 453-465.

Lusk, J. L. (2010). "The Effect of Proposition 2 on the Demand for Eggs in California." *Journal of Agricultural & Food Industrial Organization*, *8*(1).

McFadden, D. (1974), "Conditional Logit Analysis of Qualitative Choice Behavior," in P. Zarembka, eds., Frontiers of Econometrics, New York, Academic Press.

McFadden, D. (1978), "Modeling the Choice of Residential Location," in A. Karlgvist, et al., eds., Spatial Interaction Theory and Planning Models, Amsterdam: North-Holland.

McFadden,D. (1981), "Econometric Models of Probabilistic Choice," in C.F. Manski and D. McFadden, eds., Structural Analysis of Discrete Data with Econometric Applications, Cambridge: MIT Press.

McFadden,D. (1984), "Econometric Analysis of Qualitative Response Models," in Z. Griliches and M. Intilligator, eds., Handbook of Econometrics, Volume III, Amsterdam: North-Holland.

McFadden, D. and Kenneth Train (2000) "Mixed MNL models for discrete response," Journal of Applied Econometrics, 15(5), pages 447-47 .

Nevo, A (2000a),"Mergers with Differentiated Products: The Case of the Ready-to-Eat Cereal Industry." The RAND Journal of Economics, 31(3), 395-4 1.

Nevo, A (2000b),"A Practitioner's Guide to Estimation of Random Coefficients Logit Models of Demand." Journal of Economics and Management Strategy. 9(4): 513-548.

Nevo, A. (2001). "Measuring Market Power in the Ready-to-Eat Cereal Industry." *Econometrica*, *69*(2), 307-342.

Richards, T. J., Acharya, R. N., & Molina, I. (2011). "Retail and Wholesale Market Power in Organic Apples." *Agribusiness*, *27*(1), 62-81.

Table 1. Estimated Results for Demand Parameters

Variable	Means	Interactions with Demographic Variables: Log(Income)	Interactions with Demographic Variables: Child
Price	-1.51** (-2.12)	-	-
Package size	1.05** (2.54)	-	-
Egg size	0.12 (0.09)	-	-
Organic	-14.72 (-0.08)	5.00 (0.06)	6.85 (0.18)
Nutrient	-5.42 (-0.07)	-1.14 (-0.02)	-9.62*** (-28.76)
Additive-free	-20.44 (0.00)	5.04 (0.04)	15.12 (0.54)
Brown shell	-32.58 (-0.19)	-	-

*Note: t-values are given in parentheses. *, **, and *** represent 10%, 5%, and 1% significant level, respectively.*

Table 2. Own- and Cross-Price Elasticities for Selected Egg Products

	Private label						Eggland's Best					Farmhouse	Land O'Lakes		Willamette
Attribute	Conv	Conv	Nutrient, Additive-free	Organic, Brown	Brown	Brown	Nutrient	Nutrient	Nutrient, Brown	Conv	Organic, Brown	Conv	Brown	Brown	Conv
Package size & Egg size	12/pk M	18/pk M	18/pk LG	12/pk M	18/pk LG	12/pk M	12/pk M	12/pk LG	12/pk M	18/pk M	12/pk M	12/pk M	12/pk M	12/pk LG	12/pk M
#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	-1.87	0.15	0.00	0.00	0.00	0.00	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.22	-2.46	0.00	0.00	0.00	0.00	0.03	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00
3	0.12	0.08	-2.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.02	0.01	0.00	-3.05	0.10	0.62	0.00	0.00	0.00	0.00	1.22	0.00	0.06	0.04	0.00
5	0.02	0.02	0.00	0.32	-1.94	1.40	0.00	0.00	0.64	0.00	0.14	0.00	0.21	0.14	0.00
6	0.03	0.02	0.00	0.25	0.18	-1.37	0.00	0.00	0.60	0.00	0.11	0.00	0.22	0.15	0.00
7	0.21	0.16	0.00	0.00	0.00	0.00	-2.71	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.20	0.16	0.00	0.00	0.00	0.00	0.09	-2.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.01	0.00	0.00	0.00	0.18	1.27	0.01	0.00	-3.01	0.00	0.00	0.00	0.19	0.13	0.00
10	0.19	0.17	0.00	0.00	0.00	0.00	0.03	0.02	0.00	-2.76	0.00	0.00	0.00	0.00	0.00
11	0.02	0.01	0.00	2.72	0.10	0.59	0.00	0.00	0.00	0.00	-4.86	0.00	0.06	0.04	0.00
12	0.22	0.16	0.00	0.00	0.00	0.00	0.03	0.02	0.00	0.00	0.00	-2.52	0.00	0.00	0.00
13	0.03	0.03	0.00	0.14	0.16	1.23	0.00	0.00	0.51	0.00	0.06	0.00	-3.34	0.15	0.00
14	0.03	0.03	0.00	0.15	0.16	1.24	0.00	0.00	0.51	0.00	0.06	0.00	0.23	-3.38	0.00
15	0.22	0.15	0.00	0.00	0.00	0.00	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	-2.24

Table 3. Own- and Cross-Price Elasticities from AIDS Model

	Organic	Nutrient	Additive-free	Brown	Conventional
Organic	-1.07	1.11	-0.11	0.12	-0.05
Nutrient	0.43	-0.95	0.05	0.44	0.03
Additive-free	-1.05	1.09	-0.43	0.20	0.19
Brown	0.07	0.69	0.01	-1.55	0.77
Conventional	-0.00	0.01	0.00	0.11	-0.11

Table 4. Recovered Marginal Costs and Margins

Brand	Attributes	Package size & Egg size	Price	Marginal Cost	Margin
Private label	Conventional	12/pk & M	1.71	0.80	0.53
	Conventional	12/pk & LG	1.90	1.03	0.46
	Conventional	18/pk & LG	2.97	1.87	0.37
	Conventional	20/pk & LG	3.46	2.20	0.36
	Conventional	6/pk & LG	1.64	0.83	0.49
	Conventional	12/pk & XL	2.07	1.17	0.43
	Conventional	12/pk & S	1.53	0.73	0.52
	Conventional	30/pk & S	3.68	2.35	0.36
	Conventional	18/pk & M	2.69	1.60	0.41
	Conventional	30/pk & M	3.06	1.93	0.37
	Conventional	6/pk & M	1.19	0.44	0.63
	Conventional	8/pk & M	1.33	0.57	0.57
	Conventional	24/pk & M	3.25	2.07	0.36
	Nutrient & Additive-free	18/pk & LG	3.49	2.17	0.38
	Organic & Brown	12/pk &M	3.77	2.53	0.33
	Brown	18/pk & LG	1.60	0.78	0.51
	Brown	12/pk & M	2.15	0.58	0.73
Eggland's Best	Nutrient	12/pk & M	2.75	1.73	0.37
	Nutrient	12/pk & LG	2.97	1.91	0.36
	Nutrient & Brown	12/pk & M	3.46	2.31	0.33
	Conventional	18/pk & M	3.79	2.42	0.36
	Organic & Brown	12/pk & M	4.02	3.19	0.21
Farmhouse	Conventional	12/pk & M	2.41	1.46	0.40
Hillandale	Conventional	12/pk & M	1.41	0.64	0.55
Land O'Lake	Brown	12/pk & M	3.19	2.23	0.30
	Brown	12/pk & LG	3.14	2.21	0.30
Rose Acre Farms	Conventional	12/pk & M	1.56	0.76	0.51
Undefined	Conventional	12/pk & XL	1.56	0.77	0.51
	Conventional	12/pk & M	1.57	0.78	0.51
Willamette	Conventional	12/pk & M	1.92	1.07	0.45