Retail Competition in the Milk Market in a U.S. Midwestern City

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Selected Paper prepared for presentation at the Southern Agricultural Economics Association Annual Meeting, Corpus Christi, TX, February 5-8, 2011

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Abstract

The main goal of this manuscript is to explore the retailer conduct in the milk market in a U.S. Midwestern city, based upon a structural estimation of consumer milk demand and retailer optimality conditions. To model milk demand we rely upon the Almost Ideal Demand System, while allowing the retailer optimality conditions to cover a range of competitive scenarios from perfect competition to horizontal cartel. We employ a conjectural variation approach in the spirit of Newly Empirical Industrial Organization to study the competitive environment on the retail landscape.

We find that the retail market in question is far from being competitive, with the two major retailers being engaged in an oligopolistic competition. Furthermore, the private label milk seems an important tool for some big players to extract rents from their competitors.

The current study offers an idea of the competitive atmosphere in the retail sector of food marketing system. While we do not target direct estimates of retailer market power, this might serve an important first step to understand the nature of competition in a given market with only aggregate purchase quantity and price data.

Keywords: AIDS demand, conjectural variation, market power, oligopolistic competition.

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Introduction

Farm level prices of the dairy products have been on a rise in the U. S. until recently, nevertheless their annual increments have always lagged behind the rate of increase in retail prices. Meantime, the food marketing system has become increasingly concentrated in downstream channels, with retailers having their share increased from 16 percent to 36 percent over the past three decades (U.S. Government Accountability Office). Despite potential gains from economies of scale, some fear that rising concentration on the retail end might come at the expense of final consumers and farmers as well. A recent sudden drop in farm level milk prices with relatively stable retail prices only provides support to the above argument.

The main goal of this manuscript is to explore the retailer conduct in the milk market in a Midwestern city in the U.S., using product-level weekly scanner data from Information Resources Incorporated (IRI) that spans a period from 2001 to 2006. Specifically, we estimate milk demand and supply relations in a structural setting using a conjectural variation approach in the spirit of Newly Empirical Industrial Organization. Conjectural variation parameter represents the collective response of the competitor firms as perceived by a firm to a unitary change in own quantity produced (Bowley, 1924). With proper specification these parameters allow modeling various oligopoly scenarios and represent the degree of competitiveness in the market (Dixit, 1986).

Our analysis follows a methodology proposed by Hyde and Perloff (1998). Unlike them, we employ an Almost Ideal Demand System (AIDS) model of demand that is less restrictive than its linear approximate (LA/AIDS estimated with Stone's index for the nonlinear price aggregator)[3]. Furthermore, the supplier optimal conditions are derived within a utility maximizing framework with the AIDS demand specification underlying consumer price sensitivity. Secondly, we

[3] This is true, especially when correlation between prices of products in question is weak at best

explore the retailer market conduct within a single industry, namely milk industry, as opposed to multi-industry studies of market conduct. This approach may fit the task better, given that competition is of local nature for the most part.

We find that the retail market in question is far from being competitive, with the two major retailers being engaged in an oligopolistic competition. Furthermore, the private label milk seems an important tool for some big players in their dealings against major competitors on the horizontal competitive landscape.

The next section presents the methodology underlying this study. A brief description of the IRI scanner data used to study retailer market behavior is presented next. Section 4 provides the empirical results of our econometric estimation and major findings find their reflection in conclusion.

Conceptual model

In this manuscript we study the market conduct of major retail chains in a Midwestern U.S. city using market-level data on milk disappearance over a period of six years. To do so, we use a structural framework where certain behavioral assumptions for the milk consumers underlie the milk demand and supply relationships. In other terms, demand equations are derived from economic theory and supply equations incorporate consumer price sensitivity to model a range of possible equilibria in an oligopolistic environment.

Demand model

An incomplete demand system for milk is modeled via Almost Ideal Demand System assuming milk is weakly separable from other consumables in food basket (Deaton and Muellbauer, 1980). It is derived for rational consumers with price independent, generalized logarithmic preferences

(PIGLOG) and provides a first-order approximation to any demand system representing utility maximizing behavior. The AIDS specification has long been a workhorse model in applied demand studies due to functional flexibility and the relative ease of imposing theoretical restrictions. The underlying indirect utility function for the AIDS model is given by:

$$\ln V = \ln(m) - \ln(P) \;/\; b(p) \qquad (1)$$

Where m is the total expenditures on products under study, ln(P) and b(p) are translog and Cobb-Douglass price aggregator functions, respectively, specified as follows:

$$\ln(P) = \alpha_0 + \sum_{j=1}^{n} \alpha_j \ln(p_j) + 0.5 \sum_{j=1}^{n} \sum_{i=1}^{n} \gamma_{ij} \ln(p_j) \ln(p_i) \qquad (2)$$

$$b(p) = \prod_{k=1}^{n} p_k^{\beta_k} = \exp \sum_{l=1}^{n} \beta_l \ln(p_l) \qquad (3)$$

With p_j being the price of the j^{th} commodity, and $\alpha_i, \gamma_{ij}, \beta_i$ are parameters. Since α_0 in (2) is not identified in empirical work, we fix it at some value as suggested by Deaton and Muellbauer (1980).

Using the indirect utility function above, we obtain the uncompensated demand functions (Marshallian demand) via Roy's identity as follows:

$$q_i = (m / p_i) \quad \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln(p_j) + \beta_i \ \ln \quad m / P \qquad (4)$$

The respective budget share equations for the AIDS demand specification are then obtained by multiplying both sides of (4) with a factor of p_i/m:

$$s_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ \ln(p_j) + \beta_i \ln \ m / P \qquad (5)$$

Where s_i is the budget share of the i^{th} commodity

Respective theoretical restrictions of aggregation, homogeneity and symmetry imposed on the demand system are given by:

$$\sum_{i=1}^{n} \alpha_i = 1, \qquad (6)$$

$$\sum_{i=1}^{n} \beta_i = 0, \qquad (7)$$

$$\sum_{j=1}^{n} \gamma_{ij} = 0, \text{ and } \gamma_{ij} = \gamma_{ji} \ \forall \ j \neq i, \qquad (8)$$

We calculate uncompensated and expenditure elasticity estimates via respective formulas as provided in Green and Alston (1990):

$$\varepsilon_{ij} = -\delta_{ij} + \gamma_{ij} / s_i - \beta_i / s_i \ \ \alpha_j + \sum_k \gamma_{kj} \ln p_k \qquad (9)$$

$$\eta_i = 1 + \beta_i / s_i \qquad (10)$$

Where δ_{ij} is the Kronecker delta

Optimality conditions

Structural estimation of demand also requires supplier optimality conditions incorporated into the system to be estimated. To obtain these relationships, we follow Bresnahan (1982) to equate effective marginal revenue to marginal cost as follows:

$$p_i + \lambda_i \frac{\partial p_i(q_i)}{\partial q_i} q_i = c_i'(q_i) \qquad (11)$$

Here $c_i'(q_i)$ represents the marginal cost function, and $\lambda_i \in 0, 1$ measures the level of competition in a given retail market. Its value of zero implies perfect competition, while one signifies a retail cartel acting on a horizontal competitive landscape. Infinitely many oligopolistic scenarios fall somewhere in between these two extremes. The parameter λ_i is also known as a conjectural variation parameter, which represents a firm’s perception of its competitive surrounding. Specifically, conjectural variation parameter represents the collective response of the competitor firms as perceived by a firm to a unitary change in own control variable (Bowley, 1924). With proper specification these parameters allow modeling various oligopoly scenarios and represent the degree of competitiveness in the market (Dixit, 1986).

Following Hyde and Perloff (1998), we assume constant marginal cost structure given as follows:

$$c_i^{'}(q_i) = a_i + b_i v_i + d_i w \qquad (12)$$

Where v_i is Class I milk price (used as a proxy for the wholesale price), and w is the retail sales level.

Next, we obtain the slope of inverse demand function for the AIDS model holding total expenditures and prices of related products unchanged:

$$\frac{\partial p_j}{\partial q_i} = -\frac{p_j}{q_i}\left[\delta_{ij} - \frac{\gamma_{ij}}{s_i} + \frac{\beta_i}{s_i}\ \alpha_j + \sum_i \gamma_{ij} \log p_i \ \right]^{-1} \qquad (13)$$

Substitution of (12) and (13) into optimality condition (11) yields a system of estimable optimality equations:

$$p_i = \left[a_i + b_i v_i + d_i w - \frac{\lambda_i p_j q_j}{q_i} \sum_{j \neq i} \left(\frac{\gamma_{ij}}{s_i} + \frac{\beta_i}{s_i}\ \alpha_j + \sum_k \gamma_{kj} \ln p_k \ \right)^{-1} \right] x$$

$$\left[1 - \lambda_i / \left(1 - \frac{\gamma_{ii}}{s_i} + \beta_i\ \alpha_j + \sum_k \gamma_{kj} \ln p_k \ \right) \right]^{-1} \qquad (14)$$

The structural model is then represented by the budget share equations (5), retailer optimality conditions based on AIDS specification as provided by (14), and theoretical restrictions of homogeneity, adding-up, and symmetry reflected in (6), (7), and (8), respectively.

Data

The IRI data used in this study cover market-level purchase quantities of certain milk brands and total dollar amount spent on them in a Midwestern city. It is a weekly dataset from 2001 through 2006. The choice of the city is explained by the high level of retail concentration throughout the period under study. Specifically two major retailers account for over 50% of the total market share. Particularly, the retailer one is responsible for around 35 % of this measure (Market Scope, various years), and its average share in the dataset at hand is 26.5 %. As regards the manufacturers, private labels have the biggest share (over 36%) followed by the Dean Foods (2.4 %).

Products are defined as manufacturer-retailer combinations as shown below:

Table 1 Products defined

Product #	Characteristics	
	Manufacturer	Retailer #
1	Dean Foods	1
2	Dean Foods	2
3	Johnson&Johnson	1
4	Johnson&Johnson	2
5	Private Label	1
6	Private Label	2

Note: Milk is aggregated for a given combination of manufacturer and retailer on a weekly basis.

Since retail prices are not observed we compute the imputed unit values for six milk products above. Furthermore, we deflate prices from 2002 onwards using an aggregate CPI measure for urban areas. The IRI dataset was supplemented by data on cost components of milk production, specifically Class I milk price that is used in the marginal cost function (Dairy Markets Data, various years).

Empirical results

We employ GAUSSX module of the GAUSS software to estimate the AIDS model and its linear approximate. One demand equation (product # 6) was dropped due to adding up restriction. The parameter estimates for the omitted equation are obtained from the theoretical restrictions imposed on the model. A total of 67 parameters are estimated, including those of conjectural variation (table 2)[4]. Overall, the AIDS model seems to provide a better fit than LA/AIDS. As regards the parameters of conjectural variation, five out of six came out significant for both models, and the respective measures are quite close. The average conjectural variation parameter estimate for retailer one is 67.3%, while that for retailer 2 is 50.3%. Meanwhile, private label milk sold by retailer one turns out to have the highest estimate.

While it is hard to interpret conjectural variation parameter estimates that lie reasonably far from the endpoints of a unitary interval, we get a clear idea that retail competition in this geographical market is far from being perfect. Anecdotal evidence supports our findings in that retailer one is more powerful and might be exercising more market power than its major rival. Furthermore, retailer one seems to use its own brands as a major competitive tool on the horizontal competitive landscape.

We also present own price uncompensated and expenditure elasticity estimates (table 3). The uncompensated own-price elasticity measures conform to theoretical expectations as far as sign, and are statistically significantly different from zero. All of them are almost unitary elastic, which might be explained by the availability of vast many brands of milk vying for consumers' dollars. As regards the expenditure elasticity estimates, Dean Food's milk offered by retailer one had the highest measure, while milk produced by Johnson & Johnson and offered at retailer two had an inelastic estimate. We should bear in mind, however, that this study uses aggregate data

[4] The estimates of all other parameters not reported in the table are available upon request

where various specialty milk are combined with regular milk. Thus one interpretation of a finding that some milk products are inferior goods with others being normal, is that there might be more specialty milk (organic, lactose free, and so on) in the latter group of milk products than in the former one.

The current study offers an understanding of the competitive atmosphere in the retail sector of food marketing system. While we do not target direct estimates of retailer market power, however, this might be an important first step observing how markets operate without having access to rich and very detailed data.

Conclusions

The main goal of this research study is to explore the competitive environment in the U.S. food retailing sector. We estimate a system of consumer demand and retailer optimality conditions in a structural setting following a conjectural variation approach in NEIO. We rely on AIDS neoclassical demand specification to model milk demand, and retailer optimality relationships allow for types of competition ranging from perfect competition to cartel.

Our findings show that the retail market in question is far from being competitive, with the two major retailers being engaged in an oligopolistic competition. Furthermore, the private label milk seems an important tool for the biggest retailer to compete on a horizontal competitive landscape.

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Table 2 Conjectural variation parameter estimates from LA/AIDS and AIDS demand models

	LA/AIDS		AIDS	
Parameter	Parameter estimate	S. E.	Parameter estimate	S. E.
λ_1	**0.778**	0.015	**0.720**	0.019
λ_2	**0.708**	0.025	**0.689**	0.025
λ_3	**0.412**	0.025	**0.400**	0.026
λ_4	**0.370**	0.049	**0.316**	0.051
λ_5	**0.824**	0.011	**0.898**	0.018
λ_6	0.000	0.043	0.000	0.054

Note: Bold identifies parameter estimates statistically significant at 0.5 % level of significance based on a one tailed test. Standard errors are asymptotic estimated via delta method.

Table 3 Elasticity estimates from the AIDS demand model

	Coefficient	S. E.
Own-price elasticity		
Milk 1	**-1.009**	0.002
Milk 2	**-0.981**	0.002
Milk 3	**-1.000**	0.001
Milk 4	**-0.998**	0.001
Milk 5	**-1.000**	0.014
Milk 6	**-1.074**	0.013
Expenditure elasticity		
Milk 1	**1.726**	0.146
Milk 2	**1.097**	0.078
Milk 3	**1.000**	0.049
Milk 4	**0.771**	0.051
Milk 5	**1.000**	0.025
Milk 6	**0.970**	0.035

Note: Bold identifies parameter estimates statistically significant at 0.5 % level of significance based on a one-tailed test. Standard errors are asymptotic estimated via delta method.