Supermarkets Price Competition in Dallas Fort Worth Fluid Milk Market

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1. Introduction

Dallas-Fort Worth fluid milk consumers have been benefiting from a price war among supermarket chains that has lowered the prices of milk to levels as low as 99 cents per gallon. One question that comes to the researcher and policy makers minds concerns the level of competition prevailing in the Dallas-Fort Worth supermarket industry. Also of importance is the pricing strategies used by different players to gain market share in a market where Wal-Mart aggressive entry is a daily actuality.

This article pursues two objectives: The first is to estimate the effect of the price war on the fluid milk demand in the Dallas-Fort Worth market. This will allow measuring consumers' price sensitivity before and during the price war. The second objective is to assess the supermarket pricing conduct through estimating the price-cost margins of the retailers in selling fluid milk, and how these margins vary with the price war.

The issue of measuring the degree of competition in an oligopolistic market has been the focus of many studies in empirical industrial organization. In this literature, there have been two documented approaches: One is the conjectural variation approach,

where the focus is on estimating a conduct parameter that informs on the degree of competition of the market or industry analyzed, and that nests the perfect competition, the perfect collusion, and the Cournot/Bertrand models (e.g., Iwata, 1974; Gollop and Roberts, 1979, Appelbaum, 1982; Liang, 1989).[1] The second approach is the menu approach, where a number of models based on strategic games played by firms, are estimated and compared to find which game describes the data more consistently. This paper proceeds by assuming that the firms follow a horizontal Nash-Bertrand game.

The model is estimated with four-week-ending data from Dallas-Fort Worth milk market area at the supermarket level. First a discrete choice model, namely the multinomial logit model, is used to estimate the demand for fluid milk at the retail level, the relevant point of consumer's choice. The demand parameters are then used to estimate the price-cost margins of each retailer before and during the price war.

The rest of the paper is organized as follows. Sections 2 and 3 describe the Dallas-Fort Worth supermarket industry and the fluid milk market in that region. In section 4, a conceptual model is developed for estimating the demand for fluid milk and the price-cost margins earned by each retailer. Data and estimation issues are described in section 5, while the empirical results presented in section 6. The final section concludes.

2. Dallas Fort Worth Supermarket Industry[2]

In Dallas Fort Worth, the supermarket industry is dominated by five supermarket chains: Albertsons', Kroger, Minyard, Win Dixie and Tom Thumb, which control more

[1] For a critique on conjectural variation approach, see Corts (1999).
[2] The information contained in this section comes from the retailers' websites and the Market Scope, a publication of Trade Dimensions.

than 71 percent of total grocery sales in Dallas Fort Worth market. In this market area, Albertsons' supermarket chain leads the grocery market by controlling more than 28 %, followed by Winn Dixie, with 16.7%; Kroger, with 15.3%; Minyard, with 13 %; and Tom Thumb, with 12%.

Albertsons supermarket chain, owned by Minnesota based Supervalu, is a supermarket retailer that was founded by Joe Albertson in 1939. Since then the chain knew a dynamic evolution through partnership and acquisitions. Thus, in the late 1960's Albertsons supermarket chain partnered with Skaggs Companies to create a combination grocery/drug stores. This partnership was dissolved in 1977, and the Skaggs stores were acquired by Albertsons in 1992. In 1999, Albertsons acquired American Stores Company and becomes the largest American grocery operator, with over 2500 stores in 37 states. In Dallas Fort Worth, Albertsons supermarkets operated more than 62 stores in 1996, representing approximately 2.5 million square feet of space and more than $25 million of weekly grocery sales. By 2000, Albertsons supermarkets operated 82 stores in the Dallas Fort Worth market, totaling more than 4.2 million square feet of space, which represents an increase of 69 % over 1996. However, the weekly grocery sales decreased by 24 % over 1996 and totaled approximately $20 million of weekly grocery sales.[3]

Kroger supermarket chain is an American retail supermarket chain, founded in 1883 by Bernard Henry Kroger in Cincinnati, Ohio. Kroger is the top grocery retailer in the country and operates more than 2500 supermarkets in 31 states, with a wide variety of store formats. In Dallas Fort Worth, Kroger ranks second behind Albertsons in the grocery sales. In 2000, Kroger operated 64 supermarket stores totaling more than 3

[3] The years 1996 and 2000 are used for comparison because the data used in this study spans from March 1996 to July 2000.

million square feet of space, an increase of 29 % over 1996, when Kroger operated 66 supermarket stores, totaling approximately 2.4 million square feet of space. As for Albertsons, the Kroger weekly grocery sales decreased from more than $18.7 million in 1996 to approximately $13.3 million in 2000.

Tom Thumb supermarket chain is the third grocery retailer in the Dallas Fort Worth metroplex. Tom Thumb was founded in 1948 by J.R. Bost and Bob Cullum. It saw many acquisition and partnership, specially the one with Wal-Mart in 1987 to create Hypermart USA stores, rapidly dropped out in 1991 due to the lack of success. Tom Thumb was then acquired by Randall's Food Markets chain of Houston in 1992, which in turn was acquired by Safeway in 1999. Safeway retained the Tom Thumb name in Dallas-Fort Worth. In 1996, Randall's operated 48 stores, totaling more than 1.5 million square feet of space, in the Dallas Fort Worth area under the Tom Thumb banners; and generating more than $16 of weekly grocery sales. These figures increased to 57 stores under Tom Thumb banners in 2000, totaling approximately 2.6 million square feet of space and more than $18.8 of weekly grocery sales.

Minyard supermarket chain is a local chain founded in the 1930's. Currently, Minyard supermarket chain operates 65 supermarkets in the Dallas-Fort Worth metroplex, including 24 Minyard, 18 Sack'n Save, and 23 Carnival Food Stores.[4] The number of Minyard supermarket stores decreased from 48 in 1996 to 43 in 2000. However, the space controlled by Minyard increased from 1.1 million square feet in 1996 to 1.5 million square feet in 2000; while the weekly grocery sales dropped from $8.7 million in 1996 to $7.3 million in 2000.

[4] This data used in this study does not include Sack'n Save and Carnival Food Stores.

The last retailer considered in this study is Winn Dixie supermarket chain. Winn Dixie is an American supermarket chain that was founded in 1925 by the Davis family in Burley, Idaho. The family moved to Miami, Florida and a new era of growth and acquisition started. The family bought 51 % of Winn-Lovett and adopted Winn-Lovett as the company name. Winn-Lovett continued to grow by acquiring other chains such as Steiden Stores chain in Kentucky and Margaret Ann Stores in Florida. In 1955, Winn-Lovett bought Dixie Home chain stores and became Winn-Dixie. In Dallas Fort Worth, Winn Dixie operated 40 supermarket stores, representing 1.2 million square feet of space and yielding $8.85 million of weekly grocery sales. By 2000, Winn Dixie operated 48 stores, totaling 2.1 million square feet of space and $8.3 million of weekly grocery sales. In the mid 2000, the Federal Trade Commission (FTC) blocked Kroger's acquisition of Winn Dixie Texas, because Kroger would hold more than a third of the market if it buys Winn Dixie's Texas stores.

2. Dallas Fort Worth Fluid Milk Market

The Dallas Fort Worth fluid milk market is an interesting case study where the intervening supermarkets use the fluid milk pricing as a strategy to compete against each other and against the other retail formats. The fluid milk pricing conduct of the Dallas Fort Worth retailers during March 1996 through July 2000 can be decomposed in two different periods. During the first period (March 1996 to April 1999), the retail milk prices continue to vary as a response to the variation of the farm price, with the response being immediate when the farm price increases and slow and lagged when the farm price decreases. Using the four-weekly data from Information Resources Incorporated-Infoscan (IRI), the partial correlation coefficient between the farm price and the retail prices range

from 0.47 (correlation between Tom Thumb fluid milk prices and the farm price) to 0.67 (correlation between Kroger fluid milk prices and the farm price). During the second period (May 1999 to July 2000), the pricing conduct of the five supermarkets degenerates into a price war. In May 1999, Kroger began dropping the fluid milk prices and the average milk price in Kroger's stores reached $1.29/gallon. Some competitors such as Albertsons and Winn Dixie quickly followed, setting the fluid milk prices at $0.79/gallon in some stores. The partial correlation coefficient between farm price and retail prices dropped significantly to almost zero (the correlation between the farm price and Winn Dixie prices was 0.02)

During the price war, the pricing strategies of the five supermarket chain in Dallas-Fort Worth switched from a non-competitive conduct where the spread between the retail price and the farm price was widening to a conduct where fluid milk was priced below its costs (GAO, 2001). The supermarket chains move together to a great extent during the first period, as shown in Figure 1. The partial correlation coefficient of the retail milk prices for the five supermarkets ranges from 0.79 to 0.93, showing that the retailers follow each other in setting the fluid milk prices. During the price war, the partial correlation coefficient of the retail milk prices for the Dallas-Fort Worth supermarkets dropped significantly and some of them were even negative, implying price movement in different directions (See Table 1).

4. The Model

4.1. Demand Side

We assume that fluid milk is differentiated across supermarkets. This differentiation is the result of the differences between supermarket chains in many

dimensions: one-stop shopping convenience, promotional activities, location, and the quality of the service offered to shoppers. The consumer chooses a supermarket chain from competing supermarkets in order to maximize utility, driven by the store characteristics. The consumer has also the possibility to shop from other store formats (the outside option).[5] The indirect utility from shopping at the supermarket *j* is given by[6]

$$U_j = \theta_0 + \alpha p_j + \beta x_j + \varepsilon_j \ , \quad j = 1,...,J \tag{1}$$

where x_j is a vector of the *observed* supermarket chain characteristics, p_j is the price of the fluid milk sold at the supermarket chain j, α and β are taste parameters to be estimated, and ε_j represents the distribution of consumer preferences around the unobserved product characteristics with a probability density function $f(\varepsilon)$.

If we assume that ε_j is distributed *i.i.d.* with a type I extreme value distribution, i.e., $f(\varepsilon) = e^{e^{-\varepsilon}}$, then the market shares of the jth supermarket chain[7], corresponding to the probability that the jth supermarket chain is chosen, is given by the multinomial logit model as:

$$s_j = \frac{\exp(\theta_0 + \alpha p_j + x_j \beta)}{1 + \sum_{k=1}^{J} \exp(\theta_0 + \alpha p_k + x_k \beta)} . \tag{2}$$

The estimation of the multinomial logit model proceeds by the inversion proposed by Berry, Levinsohn and Pakes (1995), and is given by

$$\ln(s_j) - \ln(s_0) = \theta_0 + \alpha p_j + x_j \beta , \tag{3}$$

[5] The inclusion of the outside option is necessary to cover all the alternatives of the discrete choice model. For a detailed discussion, see Train (2003).
[6] The indirect utility comes from a quasi-linear utility function.
[7] Here the market shares are with respect of the fluid milk sales in each supermarket chain.

where s_0 is the market share of the outside option, obtained by subtracting the sum of observed market shares of the five supermarket chains from 1. Note that the logit model is transformed into a simple linear regression where the natural logarithm of the ration between the observed market shares of the supermarket chains in the set choice with respect to outside option is regressed on the store characteristics and the price variables.

The price elasticities of the market shares are given by:

$$\eta_{jk} = \frac{\partial s_j}{\partial p_k}\frac{p_k}{s_j} = \begin{cases} \alpha p_j (1 - s_j), & if \;\; j = k, \\ -\alpha p_k s_k, & otherwise. \end{cases} \tag{4}$$

4.2. Supply Side

The Dallas Fort Worth supermarket industry is characterized by a small number of firms each offering the consumers a unique bundle of products-service combination. Consider then the case where a retailer chooses the fluid milk retail price to maximize his own profits in a horizontal Nash-Bertrand competition. The jth retailer's problem is then given by maximizing

$$\pi_j = (p_j - c_j) s_j(p) M \tag{5}$$

where p_j is the fluid milk retail price, c_j is the retailer's constant marginal cost, and $s_j(p)$ is the share of the market; p is a vector of retail prices at all supermarkets; and M is market size which includes sales of fluid milk in all supermarkets and the outside option. Note that all market shares are defined relative to *M*. The first-order conditions are given by

$$s_j + (p_j - c_j)\frac{\partial s_j}{\partial p_j} = 0, \qquad j = 1,...,5 \tag{6}$$

The equilibrium price-cost margins are then given by

$$(p_j - c_j) = -(\frac{\partial s_j}{\partial p_j})^{-1} s_j = 0, \qquad j = 1,...,5 \qquad (7)$$

To take into account the effect of the price war on the strategic conduct, we assume that consumers respond differently to price changes before and during the price war. The parameter α in equation (3) is not constant and varies with time according to the following equation:

$$\alpha = \alpha_0 + \alpha_1 * W \qquad (8)$$

where W is a dummy variable equal to one during the price war and equal to zero otherwise. Substituting equation (8) into equation (3) yields:

$$\ln(s_j) - \ln(s_0) = \theta_0 + (\alpha_0 + \alpha_1 W) p_j + x_j \beta \qquad (9)$$

Therefore, equation (7) becomes

$$(p_j - c_j) = -[(\alpha_0 + \alpha_1 W)(1 - s_j) s_j]^{-1} s_j = 0, \qquad j = 1,...,5 \qquad (10)$$

5. Data and Estimation Issues

Equations (9) and (10) are the basis for estimating the effect of the price war on the consumer price sensitivity and the price-cost margins of the supermarket chains in Dallas-Fort Worth market area.

The model is estimated using Information Resource Incorporated-Infosacan (IRI) data provided by the Food Marketing Policy Center at the University of Connecticut. It includes 58 four-week-ending observations covering the period from March 1996 to July 2000. The data include the values of the fluid milk sales by each supermarket, the volume sold, and the percentage of milk sold under any merchandising. The retail fluid milk price was obtained by dividing the dollar sales by the volume sales. Supermarket chains' dummies were used as proxies for the supermarket chains' characteristics.

The model presented above (Multinomial logit) implied the need to use instrumental variables to account for the potential endogeneity of milk retail prices. This endogeneity comes from the fact that the retail prices depend on the supermarket characteristics (supermarket dummies in this case), and any variation in those characteristics will induce a variation in retail prices.

This study uses some cost data interacted with the supermarket dummies as instruments. These variables are: the farm milk price given by the Federal Milk Market Order (FMMO) announced class I (fluid milk use) price, the average retail wage in Dallas-Fort Worth market area ($/hour), a U.S. index for packaging materials from the website of the U.S. Bureau of Labor Statistics, the Moody's bond rate for 10 years as an opportunity cost for variable capital inputs obtained from Economagic, and the price of electricity for industrial use in Texas obtained from the U.S. Department of Energy website. The average volume per unit sold, from IRI database, was also included as a proxy for the amount of materials and added labor needed to supply a given volume of milk.

6. Empirical Results

The parameter estimates for equation (9) are summarized in Table 1. In general, the results appear reasonable and conform to *a priori* expectations.

The demand logit results indicate that the consumers respond negatively, as expected, to the increase in the retail prices, the price parameter being negative and highly significant (significant at 1% level). The interaction of the price war dummy variable and the price variable has a negative and significant effect on demand; this

implies that consumers will be more sensitive to price changes during the price war. The variable promotion, expressing the percentage of milk sold using any kind of merchandising, has a positive effect and is significant at 1% level. This implies that supermarkets can increase their market share by using promotion as a means to attract consumers. Regarding the supermarket chain effect, the results show that Albertsons and Kroger supermarket chains dummy variables have a positive and significant effect on the sales of fluid milk, while Minyard, Tom Thumb and Winn Dixie are negatively related to the level of sales in these supermarket chains. This can be explained by the fact that Albertsons and Kroger offer more convenient shopping than the other supermarkets by having in-store pharmacy and banking.

Table 1: Demand Parameters

Variables	Notation	Parameter	t-Statistic
Constant	θ_0	-1.6241***	33.3848
Price	α_0	-0.2924***	8.2349
Price*Price war dummy	α_1	-0.0187***	6.6867
Promotion	β_1	0.0873***	5.0893
Albertsons dummy	β_2	0.4279***	4.1552
Kroger dummy	β_3	0.1405***	2.3988
Minyard dummy	β_4	-0.2058*	1.6380
Tom Thumb dummy	β_5	-0.5967***	3.0425

Using equation (4), the own- and cross-price elasticities are computed for the pre-war period and the during-the-war period. The results (summarized in Tables 2 and 3) indicate, in general, that the own price elasticities are negative during both periods and less than 1 in absolute value. This indicates that fluid milk consumers are not sensitive to the price of fluid milk. However, the price sensitivity increases during the price war and consumers are more responsive to price changes and increase their fluid milk consumption when the retail prices plumbed during the price war. At the chain level, Kroger supermarket chain has the lowest (in absolute value) own-price elasticity for fluid milk during the pre-war period, this suggest that Kroger shoppers are less sensitive to price changes.

Table 2: Pre-war Own- and Cross-Price Elasticities

	Albertsons	Kroger	Minyard	Winn Dixie	Tom Thumb
Albertsons	-0.4881	0.0434	0.0335	0.0215	0.0424
Kroger	0.0617	-0.4554	0.0335	0.0215	0.0424
Minyard	0.0617	0.0434	-0.5419	0.0215	0.0424
Winn Dixie	0.0617	0.0434	0.0335	-0.5102	0.0424
Tom Thumb	0.0618	0.0434	0.0336	0.0216	-0.583

Table 3: Own- and Cross-Price Elasticities during Price War

	Albertsons	Kroger	Minyard	Winn Dixie	Tom Thumb
Albertsons	-0.5179	0.0454	0.0354	0.0235	0.0420
Kroger	0.0647	-0.5215	0.0354	0.0235	0.0420
Minyard	0.0647	0.0454	-0.544	0.0235	0.0420
Winn Dixie	0.0647	0.0454	0.0354	-0.5456	0.0420
Tom Thumb	0.0647	0.0454	0.0354	0.0235	-0.6047

The cross-price elasticities are all positive and very low (ranging from 0.0215 to 0.0617 during the pre-war period and from 0.0235 to 0.0647 during the price war period). This attests that although consumers are sensitive to fluid milk prices, they have developed some degree of store loyalty and would continue shopping at the same store regardless of the price charged for the fluid milk. Notice also that the cross-price elasticities with respect to a given supermarket chain is similar across the other supermarket alternatives. This is the drawback of the logit specification that exhibits what is called independent from irrelevant alternatives or IIA.

Given the demand estimates, the price-cost margins and the Lerner index[8] of the supermarket chains during the pre-war and the price war periods were computed. The results are given in Tables 4 and 5. In general, the margins are positive, attesting of some degree of market power of the supermarket chains in Dallas-Fort Worth in setting the

[8] The Lerner index is the ratio of the price-cost margin (PCM) and the price $L = \frac{PCM}{p}$

retail price.[9] During the pre-war, the price-cost margins range between $0.4459/galon in Winn Dixie supermarket chain to $0.4808/galon in the Albertsons supermarket chain. This corresponds to a Lerner index ranging from 20.67 % in Tom Thumb to 24.14% in Albertsons. These figures are comparable to the ones found by Chidmi et.al.(2005) in studying the fluid milk pricing conduct of Boston supermarket chains.

Table 4: Pre-War Price-Cost Margins for the Supermarket Chains

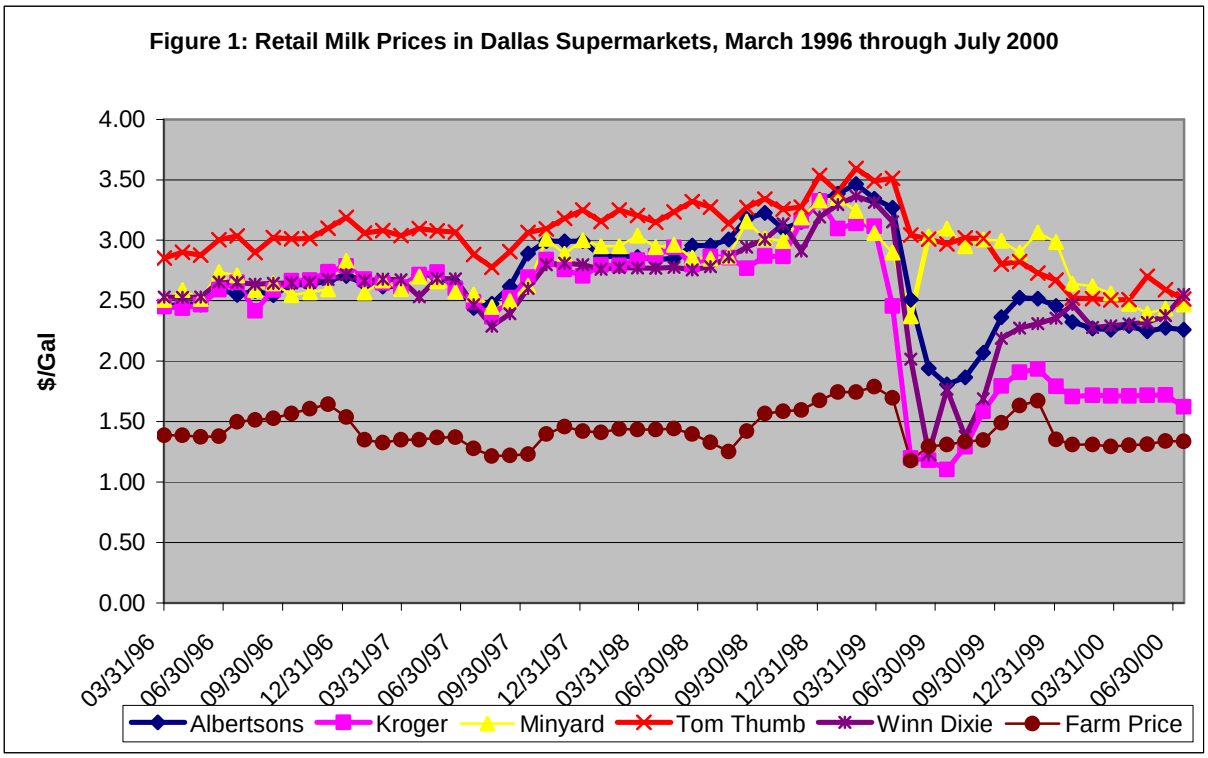
	Price-Cost Margins($/gal)	Lerner Index
Albertsons	0.4808	0.2414
Kroger	0.4647	0.2397
Minyard	0.4553	0.2298
Winn Dixie	0.4459	0.2292
Tom Thumb	0.4571	0.2067

During the price war period, the price-cost margins decreased considerably, mainly in Kroger supermarket chain. The price-cost margin for this chain went down from $0.4647/galon during the pre-war period to $0.2065/galon during the price war. In fact, Kroger was selling fluid milk way below it the farm price for more than 3 months. The other supermarket chains, though they engaged in the price war, never charged less than the farm price for their fluid milk (see Figure 1).

[9] In the perfect competition case, the retail price prevailing would be equal to the marginal cost, implying a zero price-cost margins.

Table 5: Price-Cost Margins for the Supermarket Chains during the Price War

	Price-Cost Margins($/gal)	Lerner Index
Albertsons	0.3061	0.2005
Kroger	0.2065	0.1887
Minyard	0.2752	0.1507
Winn Dixie	0.2696	0.1879
Tom Thumb	0.2846	0.1540



7. Concluding Remarks

The findings of this paper show that supermarket chains in Dallas-Fort Worth market exercise market power in setting the retail price for fluid milk. This market power persists even during the price war, during which supermarket chains used the fluid milk as a loss leader to increase their grocery market share and hypothetically as barriers to entry to the expanding Wal-Mart Super Centers in the region and also the announced entry of the San Antonio based chain H.E.B.

The results also support the general view that demand for milk is generally insensitive to milk price changes. In fact, consumers in Dallas-Fort Worth showed little price responsiveness to milk price changes during the pre-war period. Although this responsiveness increased during the price war, the demand for fluid milk in Dallas-Fort Worth supermarkets is still in the inelastic range. Also of importance in the findings is consumers' supermarket loyalty shown by the low cross-price elasticities.

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