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A STUDY OF THE DEMAND FOR ORANGE JUICE IN GROCERY STORES AND WAL-MART STORES

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Wal-Mart super-centers have grown rapidly. The openings of new Wal-Mart super-centers have direct impacts of the sales in grocery stores. ACNielsen Homescan data indicated that OJ gallon sales in Wal-Mart super-centers have grown from 8.8% of total OJ gallons sales in FY2000-01 to 13.5% in FY2003-04.

During the FY2003-04, top 3 brands, private label, and other brands accounted for 63.5, 10.6, and 25.9 percent of total gallon sales and 72.6, 9.5, and 17.9 percent of total dollar sales, respectively. OJ sold in Wal-Mart stores accounted for 13.5% total gallon sales and 11.6% total dollar sales during the same period.

Table 1 shows that during the FY 2003-04, average prices for the top 3 brands, private label, and other brands of OJ in Wal-Mart stores were $4.39, $3.48, and $2.80, respectively; these prices are lower than the prices for comparable brands found grocery store ($5.18, $4.17, and $3.12, respectively). The fastest growing OJ segment (in terms of gallon volume) in Wal-Mart stores has been the top 3 brands of OJ.

Table 2 shows that retail OJ prices in Wal-Mart stores had more variations during the study period in terms of the coefficients of variation of the retail prices. This could be the result of using ACNielsen HomeScan database to estimate the sales in Wal-Mart stores.

Demand Model

The Rotterdam model was used in this study to examine the demand relationships among the different brands of OJ in grocery and Wal-Mart stores. Formally, the model can be written as

$$(1) \qquad w_{it}dlnq_{it} = c_i + \mu_i DQ_t + \sum_j \pi_{ij} dlnp_{jt} + \varepsilon_{it}$$

where q_{it} is the average gallons of i^{th} OJ sold per person in 4-week period t, p_{it} is the average price of i^{th} OJ in 4-week period t, $w_{it} = (s_{it} + s_{it-13})/2$ (s_{it} is the expenditure share for i^{th} OJ in 4-week period t), $dlnq_{it} = \log(q_{it}/q_{it-13})$, $dlnp_{it} = \log(p_{it}/p_{it-13})$, $DQ_t = \sum_i w_{it}dlnq_{it}$, μ_i (marginal expenditure share), and π_{ij} (Slutsky price term) are parameters to be estimated, and ε_{it} is the disturbance term.

Table 1 shows that there were increasing trends in the top 3 brand OJ gallon sales in both grocery and Wal-Mart stores. There was a decreasing trend in private label OJ gallon sales in grocery stores but an increasing trend in Wal-Mart stores. Other brands of OJ gallon sales also showed an increasing trend in Wal-Mart stores. Therefore, a trend variable, c_i, was included in the Rotterdam model to capture these trends. With these trend variables, the model can be written as

(2) $w_{it}dlnq_{it} = c_i + \mu_i DQ_t + \sum_j \pi_{ij} dlnp_{jt} + \varepsilon_{it}$.

In this study, the same brand of OJ in grocery stores and in Wal-Mart stores was considered different goods in the eyes of consumers. Hence, there are six OJ products: the top 3 brands, private label, and other brands of OJ in $2MM+ grocery stores and in Wal-Mart stores. The study period covers 41 4-week periods, i.e., from 4 weeks ending 07-07-01 through 4 weeks ending 07-31-04. Iterative seemingly unrelated regression was used to estimate the demand parameters. Note that since this is a sub-demand system, i.e., we only consider the demand relationships among the OJ categories, the estimated demand elasticities are expected to be higher in absolute values than those found in Brown's studies.

The time trend coefficient estimates, marginal expenditure share parameters (μ_i), and Slutsky coefficients (π_{ij}) are presented at the top part of Table 3; income elasticity estimates ($\eta_i = \mu_i/w_i$) and uncompensated price elasticity estimates are presented in the lower half of Table 3.

Results

The trend coefficient estimates (c_i) show that there is a positive time trend for the demand for top 3 brands of OJ in grocery stores all brands of OJ in Wal-Mart stores. In addition, there is a negative time trend in the demand for private label OJ in grocery stores.

Only three of the six marginal expenditure share parameters are statistically different from zero at $\alpha = 0.05$ level, i.e., top 3 brands and other brands of OJ in grocery stores and other brands of OJ in Wal-Mart stores. All three significant income elasticity estimates are greater than unity, indications that for every one percent increase in consumers expenditures in OJ consumption, the gallon sales of top 3 brands and other brands of OJ in grocery stores and other brands of OJ in Wal-Mart stores would increase by more than one percent. Other brands of OJ in Wal-Mart stores benefit the most from increased OJ expenditure although the gallon volume was small (vice versa when there is a decrease in OJ expenditure). Note that other brands OJ gallon sales in Wal-Mart stores have increased 48% over the study period (see Table 1).

All own-price Slutsky parameter estimates (π_{ii}) and uncompensated own-price elasticity estimates ($\eta_{ii} = \pi_{ii} - w_i\eta_i)/w_i$) are negative and statistically different from zero. Eleven of the 15 cross-price Slutsky parameter estimates and 21 of the 30 uncompensated cross-price elasticity estimates are statistically different from zero.

Price elasticity estimates show that grocery store consumers are most responsive to prices changes in other brands of OJ ($\eta_{ii} = -2.97$, i.e., a one percent change in the price of other brands of OJ would cause a 2.97 percents change in the quantity demanded), then followed by private label OJ ($\eta_{ii} = -1.68$), and least responsive to prices changes in top 3 brands of OJ ($\eta_{ii} = -1.28$, brand loyalty?). In Wal-Mart stores, consumers are more

responsive to price changes in branded OJ (the own-price elasticity estimates are –3.52 and –2.52 for other brands and top 3 brands of OJ, respectively) than to the price changes in private label OJ (the own-price elasticity estimate is -1.00).

Cross-price elasticity estimates ($\eta_{ij} = \pi_{ij} - w_j\eta_i)/w_i$) show that private label OJ and other brands of OJ are substitutes while the top 3 brands of OJ and other brands of OJ are complements in grocery stores. In Wal-Mart stores, other brands of OJ and private label OJ are found to be complements. When the top-3 brand OJ price in grocery stores increases, sales of all brands of OJ in Wal-Mart stores increase and when OJ prices of all three groups of OJ in Wal-Mart stores increase, the sales of top 3 brands OJ in grocery stores increase, an indication that the top-3 brand OJ sold in grocery stores is a substitute of all OJs sold in Wal-Mart stores. When the price of other brands of OJ in grocery stores increases, the sales of private label OJ in grocery stores and the sales of top-3-brand OJ in Wal-Mart stores increase.

The complementary relationships (negative cross-price elasticities) found in this study were not expected. The uniform substitute and block independent assumptions were used in the Rotterdam model (2) to correct for these unexpected complementary demand relationships, but the results were not encouraging.

Discussion

The results found in this study suggest that grocery store and Wal-Mart store customers react to OJ price changes differently. Grocery store customers react the least to top 3 brand OJ price changes and the most to other brands of OJ price changes, while Wal-Mart store customers were the least sensitive to private label OJ price changes and most sensitive to other brands of OJ price changes.

The data used in the study are consisted of two parts: ACNielsen's ScanTrack for grocery store and ACNielsen's Homescan for Wal-Mart stores. The former is scanner data and the latter is household panel data. The marriage of these two data sources may cause the unexpected complementary demand relationships found in this study. In addition, consumers may shop at both grocery stores and Wal-Mart stores during the study period. How this shopping behavior affects the estimated demand relationship is unknown.

Table 1. Average four weeks sales statistics

52 Weeks Ending	Other Brands			TL OJ TOP 3			TL OJ P-L/GEN		
	mil gals	$mil	$/gal	mil gals	$mil	$/gal	mil gals	$mil	$/gal
					$2MM+ Grocery Stores				
07/06/02	5.87	23.24	$3.96	35.31	183.46	$5.20	17.83	55.92	$3.14
07/05/03	5.62	23.04	$4.10	35.29	181.62	$5.15	15.92	50.33	$3.16
07/03/04	5.10	21.26	$4.17	33.99	175.93	$5.18	13.71	42.79	$3.12
					Wal-Mart				
07/06/02	0.77	2.66	$3.45	3.09	13.57	$4.39	1.91	5.35	$2.80
07/05/03	1.14	3.82	$3.36	3.69	16.24	$4.40	2.17	6.03	$2.78
07/03/04	1.14	3.97	$3.48	4.99	21.92	$4.39	2.30	6.42	$2.80

Table 2. Sample statistics and market shares – 4 weeks ending 07/07/01 through 07/31/04

	Mean	Std Dev	Minimum	Maximum	C.V.[1]
			$2MM+ Grocery Stores		
Other Brands					
Dollar Sales ($mil)	22.42	1.62	19.57	25.55	0.072
Gallon Sales (gals)[2]	19.09	1.74	16.02	22.74	0.091
Price ($/gal)	4.07	0.12	3.83	4.28	0.029
Dollar Share	8.1%				
Gallon Share	8.8%				
To 3 Brands					
Dollar Sales ($mil)	179.68	9.47	156.59	199.14	0.053
Gallon Sales (gals)	119.96	7.61	102.57	136.18	0.063
Price ($/gal)	5.18	0.08	5.06	5.41	0.015
Dollar Share	64.6%				
Gallon Share	55.0%				
Private Label					
Dollar Sales ($mil)	49.57	6.51	36.84	60.75	0.131
Gallon Sales (gals)	54.60	7.51	41.33	69.01	0.138
Price ($/gal)	3.14	0.04	3.03	3.23	0.014
Dollar Share	17.8%				
Gallon Share	25.0%				
			Wal-Mart		
Other Brand					
Dollar Sales ($mil)	3.44	0.89	1.54	4.89	0.258
Gallon Sales (gals)	3.46	0.91	1.51	5.08	0.264
Price ($/gal)	3.45	0.13	3.21	3.86	0.038
Dollar Share	1.2%				
Gallon Share	1.6%				
Top 3 Brands					
Dollar Sales ($mil)	17.22	3.93	11.33	24.50	0.228
Gallon Sales (gals)	13.52	2.99	8.85	19.07	0.221
Price ($/gal)	4.40	0.10	4.18	4.60	0.023
Dollar Share	6.2%				
Gallon Share	6.3%				
Private Label					
Dollar Sales ($mil)	5.92	0.68	4.67	7.42	0.114
Gallon Sales (gals)	7.32	0.77	5.95	9.07	0.105
Price ($/gal)	2.79	0.05	2.70	2.90	0.018
Dollar Share	2.1%				
Gallon Share	3.4%				

[1]Coefficient of variation, i.e., standard deviation divided by mean.
[2]Gallon sales per 1,000 persons.

Table 3. Demand parameter and elasticity estimates[a]

	Intercept	μ_i	Slutsky Coefficient (π_{ij})					
			Grocery			Wal-Mart		
			Other Brands	Top 3 Brands	Private Label	Other Brands	Top 3 Brands	Private Label
Grocery								
Other Brands	0.0023	0.1296*	-0.2040*	-0.1598*	0.2591*	0.0014	0.0806*	0.0226
	(0.0041)	(0.0550)	(0.0706)	(0.0651)	(0.0440)	(0.0186)	(0.0389)	(0.0219)
Top 3 Brands	0.0112*	0.7516*		-0.3407*	0.2126*	0.0860*	0.1373*	0.0647*
	(0.0044)	(0.0684)		(0.0908)	(0.0566)	(0.0197)	(0.0446)	(0.0206)
Private Label	-0.0308*	0.0117			-0.3120*	-0.0441*	-0.0763*	-0.0393*
	(0.0029)	(0.0498)			(0.0523)	(0.0149)	(0.0367)	(0.0161)
Wal-Mart								
Other Brands	0.0056*	0.0700*				-0.0402*	0.0087	-0.0118*
	(0.0012)	(0.0184)				(0.0084)	(0.0128)	(0.0065)
Top 3 Brands	0.0100*	0.0352					-0.1343*	-0.0160
	(0.0024)	(0.0391)					(0.0379)	(0.0142)
Private Label	0.0018	0.0019						-0.0202*
	(0.0012)	(0.0160)						(0.0123)

	Income Elasticity	Uncompensated Price Elasticity					
Grocery							
Other Brands	1.5815*	-2.6195*	-2.9716*	2.8682*	-0.0014	0.8985*	0.2443
	(0.6712)	(0.8953)	(0.5920)	(0.5867)	(0.2244)	(0.4778)	(0.2640)
Top 3 Brands	1.1641*	-0.3429*	-1.2793*	0.1121	0.1196*	0.1496*	0.0767*
	(0.1059)	(0.1060)	(0.1001)	(0.0996)	(0.0303)	(0.0704)	(0.0316)
Private Label	0.0627	1.3842*	1.0992*	-1.6846*	-0.2372*	-0.4122*	-0.2120*
	(0.2671)	(0.2451)	(0.2424)	(0.3060)	(0.0794)	(0.1968)	(0.0866)
Wal-Mart							
Other Brands	6.0165*	-0.3731	3.5048*	-4.9126*	-3.5266*	0.4257	-1.1346*
	(1.5848)	(1.6718)	(1.4088)	(1.3945)	(0.7136)	(1.1173)	(0.5525)
Top 3 Brands	0.6508	1.4358*	2.1153*	-1.5298*	0.1539	-2.5167*	-0.3093
	(0.7214)	(0.7408)	(0.6647)	(0.7361)	(0.2340)	(0.7064)	(0.2624)
Private Label	0.0959	1.1141	3.1453*	-1.9668*	-0.5859*	-0.8004	-1.0021*
	(0.7941)	(1.1120)	(0.8164)	(0.8596)	(0.3173)	(0.7156)	(0.6066)
Dollar Share		0.0856	0.6453	0.1863	0.0112	0.0518	0.0197

[a]Numbers in parentheses are standard errors of parameter estimates.

*Statistically different from zero at $\alpha = 0.05$ level.