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A STUDY OF THE IMPACTSOF LOW-CARB OJ ON THE DEMAND FOR OJ

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Sales of orange juice have been dropping for three years now, coinciding with the growth in the two diets – the Atkins diet and the South Beach diet. A survey by the Florida Department of Citrus (FDOC) of consumers who drank less OJ in 2003 than they had in 2004 found that about 9% of the respondents cited the reason of drinking less OJ was because they were on low-carb diets. Orange and other fruit juices are high in carbohydrates and thus are shunned by these dieters.

Some Florida citrus companies are throwing more than money into the effort to convince consumers they can drink OJ and still lose weight. Tropicana Products has introduced a low-calorie orange juice in January of 2004. The low-carb orange juice is known as Light 'n Healthy. An 8-ounce serving of Light 'n Healthy has about 70 calories and 14 grams of sugar, about a third less than the regular Tropicana orange juice. Minute Maid introduced Premium Light in May 2004.

The low-carb OJ drinks branded products and are stocked right side by side to the 100% OJ products of the same brand. Special advertising and promotional activities accompanied the introduction of these low-carb OJ drinks. These drinks look and taste like 100% OJ products and the sales of these OJ drinks may have direct impacts on the sales of regular OJ. Figure 1 shows that since the introductions of low-carb OJ drink, the gallon sales of OJ and OJ blends have decreased. The purpose of this study is to examine the impact of low-carb OJ drink sales on the demand for regular OJ and OJ blends.

The Rotterdam Model with Additional Preference Influencing Variables

Consider the traditional consumer problem of choosing that bundle of goods which maximizes utility subject to a budget constraint

(1) maximize $u = u(q, z)$
subject to $p'q = m$,

where u is utility, $p' = (p_1, p_2, \ldots, p_n)$ and $q' = (q_1, q_2, \ldots, q_n)$ are price and quantity vectors with p_i and q_i being the price and quantity of good i, respectively; $z' = (z_1, \ldots, z_m)$ is a vector of other preference influencing variables, such as advertising, time trend, etc. The solution for (1) is the set of demand equations

(2) $q = q(p, m, z)$.

Following Barten (1964) and Theil (1976, 1980), an approximation to demand (2) is the Rotterdam model which can be written as

(3) $w_i d\ln q_i = \mu_i DQ + \sum_j \pi_{ij} d\ln p_j + \sum_k \beta_{ik} d\ln z_k \quad i = 1, 2, \ldots, n; k = 1, 2, \ldots, m,$

where $d\ln x_i = dx_i/x_i$; $w_i = p_i q_i/m$ is the budget share for good i; $\mu_i = \partial p_i q_i/\partial m$ is the marginal propensity to consume; $DQ = \sum_i w_i d\ln q_i$ is the divisia volume index; $\pi_{ij} =$

$(p_ip_j/m)s_{ij}$ is the Slutsky coefficient with $s_{ij} = (\partial q_i/\partial p_j + q_j\partial q_i/\partial m)$ or the element in the ith row and jth column of the substitution matrix; $\beta_{ik} = w_i(\partial q_i/\partial z_k)(z_k/q_i)$ is the coefficient for the kth additional preference influencing variable.

Note that when z_k has any zero values, $dlnz_k$ is undefined. To circumvent this problem, we rearrange the term $\beta_{ik}dlnz_k$ into $\beta_{ik}'dz_k$, i.e.,

(4) $$\beta_{ik}dlnz_k = (p_iq_i/m)\,(\partial q_i/\partial z_k)(z_k/q_i)(dz_k/z_k) = \partial(q_ip_i/m)/\partial z_k\, dz_k,$$

where $\beta_{ik}' = \partial(q_ip_i/m)/\partial z_k = \partial w_i/\partial z_k$ is the marginal impact of z_k on budget share w_i. Consequently, model (3) can be rewritten as

(5) $$w_i dlnq_i = \mu_i\, DQ + \sum_j \pi_{ij}\, dlnp_j + \sum_k \beta_{ik}'dz_k \qquad i = 1, 2, \ldots, n;\ k = 1, 2, \ldots, m,$$

The general demand restrictions are

(6a) adding up: $\sum_i \mu_i = 1;\ \sum_i \pi_{ij} = 0;$ and $\sum_i \beta_{ik} = 0;$
(6b) homogeneity: $\sum_j \pi_{ij} = 0;$
(6c) symmetry: $\pi_{ij} = \pi_{ji}.$

The demand elasticities can be calculated using the demand parameters in (3) as

(7a) income: $\varepsilon_{im} = \mu_i/w_i;$
(7b) price: $\varepsilon_{ij} = \pi_{ij}/w_i - w_j\varepsilon_{im}.$

Data and Variables

Demand model (5) with demand restrictions (6a) -- (6c) imposed was applied to ACNielsen weekly orange juice and orange juice blends ScanTrack data for grocery stores that had annual sales of $2MM or more. The period from week ending 06-15-02 through the week ending 09-25-04 was studied. The data were 52nd differenced (for the 52 weeks in a year) to account for seasonality. Six OJ categories were studied – five OJ brand categories, referred to as private label, Minute Maid, Tropicana, Florida's Natural, and other brands of OJ, and a sixth category for OJ blends.

There were intense advertisings when Tropicana and Minute Maid introduced their low-carb OJ drinks. These advertisings were supposed to build good will for the newly introduced low-carb OJ drinks. Even if we had detailed information about these advertising activities, it would be difficult to find a way to measure the good will out there in the market place. Instead of using advertising expenditures or activities to measure the good will created by Tropicana and Minute Maid's advertising activities, the gallon sales (in million gallons) of Tropicana and Minute Maid's OJ drinks, i.e., Tropicana's Essentials (Light & Healthy) and Minute Maid's Heart & Healthy were used as proxies of good will for the low-carb OJ drinks. In addition, a time trend variable, i.e.,

an intercept in the Rotterdam model, was included in (5) to capture the declining trends in OJ sales in grocery stores.

The iterative seemingly unrelated regression (when converges, the ISUR is equivalent to the maximum likelihood method) was used to estimate (5). The data add up by construction and the equation for the other brands of OJ was deleted (Barten 1969). The estimates are invariant to the equation deleted. The parameters of the deleted equation can be recovered by using the demand restrictions shown in (6a) through (6c), or by simply rerunning the model deleting a different equation.

Results

Table 1 shows the ML estimates of (5). The marginal propensities to consume for all OJ products are significantly different from zero. All own-Slutsky coefficient estimates are negative and significant as suggested by theory and all cross-Slutsky coefficient estimates are either positive and significant or not different from zero. The results suggest the different OJ brands and OJ blends are predominantly substitutes as expected.

The time trend coefficient estimates indicate that there were negative time trends in the expenditure shares of private label OJ and OJ blends; and positive time trends in the expenditure shares of Minute Maid and Tropicana OJ. The estimated decreases in the expenditure shares of private label OJ and OJ blends are 2.11% and 0.36% per year, respectively. The estimated increases in the expenditure shares of Minute Maid OJ and Tropicana OJ are 1.52% and 1.38% per year, respectively.

The estimates of the marginal impacts of low-carb OJ drink sales on budget shares, β_{ik}', indicate that the sales of Tropicana's Light'n Healthy had negative impacts on the expenditure shares of private label OJ and OJ blends. Results show that the estimated impacts ($\beta_{ik}'dz_k$, the sample means of dz_ks were used in the calculation) of Tropicana's Light'n Healthy sales on the expenditure shares of private label OJ and OJ blends were -0.25% and -0.14% (weekly), respectively. The impact of Light'n Healthy on Tropicana's OJ gallon sales was negative but not statistically different from zero.

Similarly, the sales of Minute Maid's Premium Light had negative impacts on the expenditure shares of it's own OJ and OJ blends. The estimated impacts of Minute Maid's Premium Light on the dollar shares of Minute Maid OJ and OJ blends are by -0.25% and -0.08% (weekly), respectively. Results also show that the sales of Minute Maid's Premium Light had an unexpected positive impact on the expenditure share of private label OJ. The result shows that the impact of Minute Maid's Premium Light on the expenditure shares of private label OJ is 0.23% (weekly).

Estimated elasticities based on the estimates in Table 1 and sample means are shown in Table 2. The income elasticity estimates indicated that Tropicana's OJ is a luxury good among the six OJ products studied, an one percent increase in total

expenditure on these six OJ products, the gallon sales of Tropicana OJ would increase by 1.45%, OJ blends would increase by 1.10% (statistically this is not different from 1.00%), and less than 1% for the other four OJs. The own-price elasticity estimates show that the top three brands, MM, Tropicana, and Florida's Natural are more price elastic than private label OJ and other brands of OJ. As expected, cross-price elasticity estimates are relatively smaller than the own-price elasticity estimates.

The result found in this study suggests that Tropicana's Light'n Healthy was able to expand at the cost of decreased expenditure shares of private label OJ and OJ blends, while Minute Maid's Premium Light expanded at the cost of reduced expenditures of private label OJ and Minute Maid OJs. These findings indicate that the sales of low-carb OJ drinks have a negative impact on the sales of OJ.

Figure 1. OJ product gallon sales, week ending 06-15-02 through week ending 09-25-04

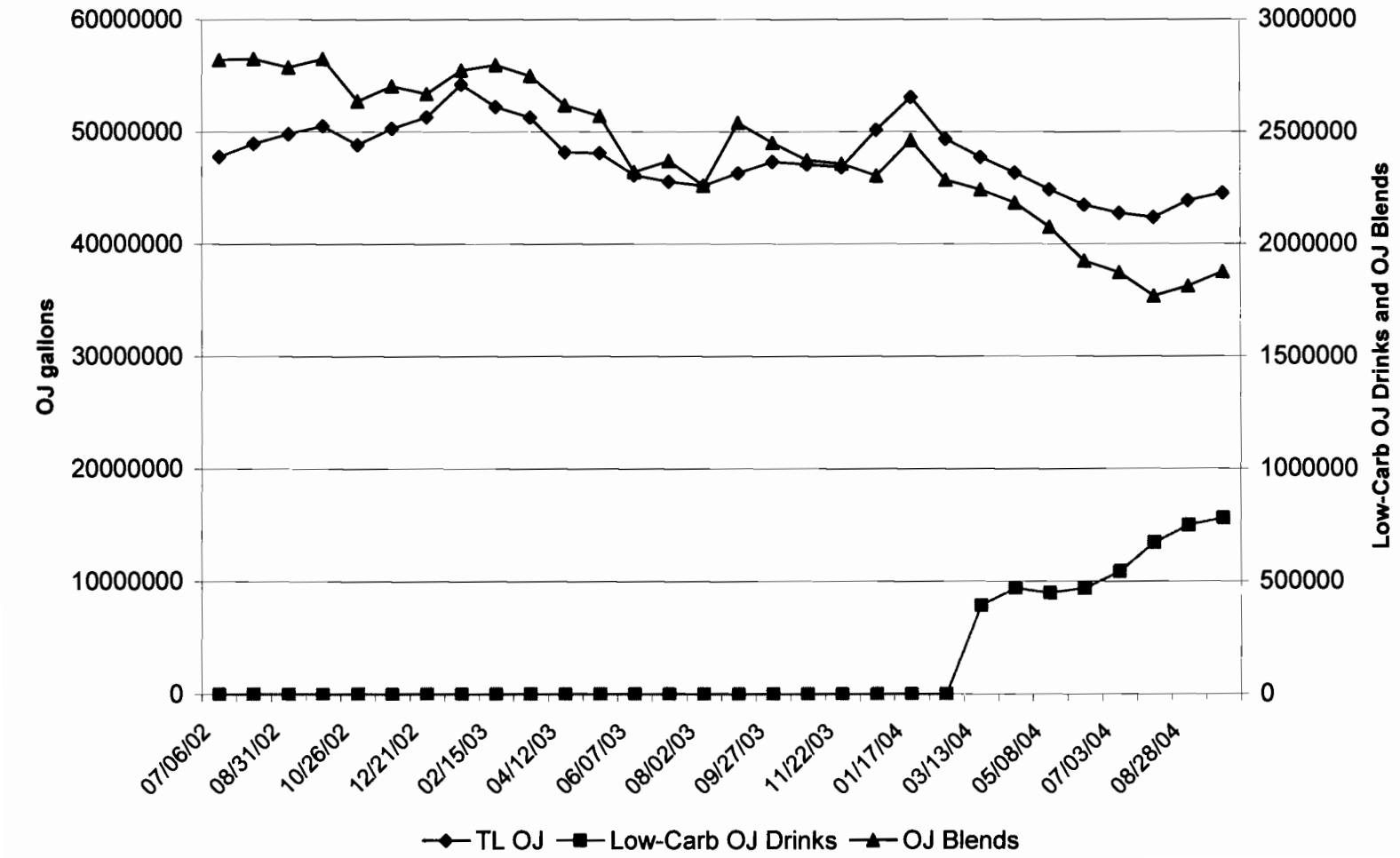

Table 1. Demand parameter estimates for (4)

	μ_i	π_{ij}						β_{ik}		
		Private Label	MM	Trop	FN	OJ Blends	Other Brand OJ	Trop OJD	MM OJD	Time Trend
Private Label	0.0547**	-0.1949*	0.0755*	0.0745*	0.0167	0.0041	0.0241*	-0.0443*	0.2112*	-0.0211*
	(0.0341)	(0.0284)	(0.0181)	(0.0224)	(0.0151)	(0.0097)	(0.0143)	(0.0242)	(0.0761)	(0.0026)
MM	0.1506*		-0.3463*	0.1926*	0.0392*	-0.0013	0.0402*	0.0255	-0.2266*	0.0152*
	(0.0507)		(0.0271)	(0.0285)	(0.0170)	(0.0078)	(0.0117)	(0.0363)	(0.1109)	(0.0038)
Trop	0.6013*			-0.4854*	0.1102*	0.0390*	0.0691*	-0.0085	0.1353	0.0138*
	(0.0766)			(0.0469)	(0.0245)	(0.0087)	(0.0136)	(0.0539)	(0.1650)	(0.0056)
FN	0.0686**				-0.2100*	0.0168*	0.0271*	0.0321	-0.0122	-0.0026
	(0.0451)				(0.0205)	(0.0057)	(0.0094)	(0.0316)	(0.0977)	(0.0033)
OJ Blends	0.0597*					-0.0493*	-0.0092	-0.0249*	-0.0758*	-0.0036*
	(0.0119)					(0.0128)	(0.0075)	(0.0084)	(0.0263)	(0.0010)
Other Brands	0.0651*						-0.1512*	0.0201*	-0.0318	-0.0017
	(0.0204)						(0.0146)	(0.0144)	(0.0451)	(0.0016)

*Statistically different from zero at $\alpha = 0.05$ level.
**Statistically different from zero at $\alpha = 0.10$ level.

Table 2. Demand elasticity estimates

	Income Elasticity	Uncompensated Price Elasticity					
		Private Label	MM	Trop	FN	OJ Blends	Other Brand OJ
Private Label	0.3572**	-1.3269*	0.4183*	0.3382*	0.0777	0.0076	0.1279**
	(0.2227)	(0.1925)	(0.1277)	(0.1451)	(0.1041)	(0.0639)	(0.0967)
MM	0.7190*	0.2505*	-1.8040*	0.6220*	0.1247**	-0.0454	0.1332*
	(0.2419)	(0.0961)	(0.1444)	(0.1448)	(0.0876)	(0.0390)	(0.0606)
Trop	1.4514*	-0.0425	0.1610*	-1.7730*	0.1395*	0.0155	0.0481**
	(0.1849)	(0.0642)	(0.0851)	(0.1143)	(0.0651)	(0.0224)	(0.0375)
FN	0.7868**	0.0707	0.2853	0.9379*	-2.4769*	0.1496*	0.2465*
	(0.5171)	(0.1956)	(0.2296)	(0.2955)	(0.2511)	(0.0695)	(0.1174)
OJ Blends	1.1021*	-0.0925	-0.2555*	0.2633*	0.2132*	-0.9701*	-0.2604*
	(0.2197)	(0.1835)	(0.1482)	(0.1526)	(0.1104)	(0.2379)	(0.1422)
Other Brands	0.7967*	0.1724*	0.3251*	0.5151*	0.2621*	-0.1561*	-0.1781*
	(0.2497)	(0.0382)	(0.0523)	(0.1034)	(0.0218)	(0.0135)	(0.0204)

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

**Statistically different from zero at $\alpha = 0.10$ level.