The Impacts of Retail Promotions on the Demand for Orange Juice: A Study of a Retail Chain

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Introduction

Food retailers use temporary price reductions, feature advertising, and displays to increase sales, revenues, and market shares. Feature advertising has been a common retail practice and includes retailer specific best-food-day advertising, store flyers, circulars, and other materials. Most of the retail advertisements are brand specific with some being major and others are relatively minor (line ads).

In-store promotional displays include the display of the products in secondary locations, cut cases placed next to regular shelf location, and those displays in primary locations but with special efforts. Displays give the product of interest more visibility and may increase the sales of the product. Temporary price reductions (TPRs), as defined in this study are price decreases that are greater than 5% of the regular prices (a regular price is the median of all prices within 5% of the maximum price in the previous seven weeks).

Sometimes feature advertising and displays may come with price reductions. When price reductions are used with feature advertising and displays, additional price effects on the sales of the products of interest could occur. In addition, a price reduction itself may have a separate advertising effect on the demand for the product of interest. Generally, increased sales of the brands or products as a result of feature advertising and displays come from at least three sources: the decreased sales of competing brands or products, more buying customers, and more purchases per buying customer. When most of the increased demand for the product or brand of interest comes from decreased sales

of competing brands or products in the same store, the store may not benefit from promoting brand or product. When the increased demand of the product comes from decreased demand for similar products in competing stores, the retailer could benefit from the promotion. The purpose of this study is to examine the impacts of TPRs, brand feature ads, and displays on the demands for different brands of orange juice (OJ) in a retail chain and competing stores in the same trading area.

Methodology

Following Barten, an approximation to demand is the Rotterdam model which can be written as

(1) $w_i dlnq_i = \mu_i DQ + \Sigma_j \pi_{ij} dlnp_j + \Sigma_j \Sigma_k \beta_{ij}^k da_j^k, \qquad i = 1, 2, \ldots, n;$

where $w_i = p_i q_i/m$ is the budget share for good *i* with p_i and q_i being the price and quantity of good *I*, and m being income; $\mu_i = p_i(\partial q_i/\partial m)$ is the marginal propensity to consume; $DQ = \Sigma_i w_i dlnq_i$ is the Divisia volume index; $\pi_{ij} = (p_i p_j/m)s_{ij}$ 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; $\beta_{ij}^k = w_i(\partial lnq_i/\partial a_j^k)$ is a promotional tactic coefficient indicating the impact of the *k*th tactic used in promoting product *j* on the demand for product *i*. The general restrictions on demand are

(2) adding up: $\Sigma_i \mu_i = 1$ and $\Sigma_i \pi_{ij} = 0$; $\Sigma_i \beta_{ij}^k = 0$

homogeneity: $\Sigma_j \pi_{ij} = 0$; and

symmetry: $\pi_{ij} = \pi_{ji}$.

The promotional (feature ad and display) coefficients can be written as (Brown and Lee 1993, 2002)

(3) $\beta_{ij}^{k} = -\Sigma_j \pi_{ih} \gamma_{hj}^{k}$, $i, j = 1, 2, \ldots, n$,

where $\gamma_{hj}^{k} = \partial \ln(\partial u/\partial q_h)/\partial a_j^{k}$ for $i, h = 1, \ldots, n$.

Expressions (3) can be used to impose restrictions on the effects of retail promotional tactics on demand (Brown and Lee 1993, 2002; Duffy 1987, 1989; Theil 1980). Because of the limited observations available for the study, the parameter space is reduced to a manageable size. Following Theil (1980), we assume that promotional tactics only affect marginal utility of the brand in question, resulting in the restriction $\beta_{ij}^{k} = - \pi_{ij} \gamma_{jj}^{k}$, and that tactic k is equally effective across brands, further resulting in $\gamma_{jj}^{k} = \gamma^{k}$. Hence, equation (3) becomes

$$\beta_{ij}^{k} = - \pi_{ij} \gamma^{k}.$$

Imposing the forgoing promotional restrictions, the demand model (1) can be written as

(4) $w_i d\ln q_i = \mu_i DQ + \Sigma_j \pi_{ij}(d\ln p_j - \Sigma_k \gamma^{k} da_j^{k})$, $i, j = 1, 2, \ldots, n$.

In this case, the demand elasticity of a retail promotional tactic is

(5) $(\partial \ln q_i/\partial \ln a_j^{k}) = -(\pi_{ij} \gamma^{k}) a_j^{k}/w_i$.

The marginal impact of a tactic on demand is estimated as (this result is an approximation, see Barten for further discussion)

$$dq_i = -(\pi_{ij} \gamma^{k}/w_i) q_i da_j^{k};$$

and the marginal impacts on retail revenue can be written as

(6) $p_i\, dq_i = -p_i\, (\pi_{ij} \gamma^{k}/w_i)(q_i da_j^{k})$.

Note that

(7) $\Sigma_i p_i dq_i = -\Sigma_i\, (\pi_{ij} \gamma^{k}/w_i) p_i q_i da_j^{k}$

$$= -\gamma^{k} * m * da_j^{k} \Sigma_i\, (\pi_{ij}/w_i)(p_i q_i/m)$$

$$= -\gamma^{k} * m * da_j^{k} \Sigma_i \pi_{ij}$$

$$= 0,$$

because of the adding-up restriction, $\Sigma_i \pi_{ij} = 0$. Thus, in the Rotterdam model, although any change in promotional activities would reallocate total expenditure to across goods, total expenditure remains constant.

Data

Nielsen provided weekly data on gallon sales, prices, and TRP, brand feature ads only, displays only, and feature ads and displays. The promotional variables are measured in terms of %ACV. The period from weeks ending on 07/03/04 through 06/24/06 (104 weeks) was studied. Demand model (4) was applied to sales data for a retail chain. The chain in question will be referred to as Retailer X in this study and competing grocery stores will be called X COMP. Five brands of orange juice – Minute Maid, Tropicana, Florida's Natural, Private Labels, and Other Brands were analyzed. In this study, we distinguish between the same brand of OJ sold by Retailer X versus competing stores, e.g., Private Label OJ in Retailer X stores is treated as a different brand of OJ from Private Label OJ in competing stores. Hence, there are ten OJ brands considered – five sold by Retailer X and five sold by competing stores.

Results

Table 1 shows the iterative seemingly unrelated regression estimates of equation (8) with homogeneity and symmetry imposed. The data for (8) add up by construction and the equation for Other OJ was deleted (Barten 1969). The estimates are invariant to the equation deleted, and the parameters of the deleted equation can be recovered by

using the demand restrictions (equation (6)) or by simply re-running the model deleting a different equation.

The marginal propensities to consume (MPC, μ_i) for all juices are positive and statistically different from zero except the ones for Private Label OJ in Retailer X and Other OJ sold by Retailer X's competitors, which are both negative but significant and the MPC estimate for Florida's Natural OJ in Retailer X, which was positive but insignificant. All own-price Slutsky coefficients are negative and statistically different from zero. Of the 45 cross-price Slutsky coefficients, 18 are positive and statistically different zero, and four are negative and significant, while the remaining 23 are not statistically different from zero. The cross-price estimates for the brands in the same stores (Retailer X or Retailer X's competitors) are all positive, an indication that the different brands in the same store are substitutes (Table 3). Note that X COMP is the aggregate of all Retailer X's competing stores in the trading area; the aggregated data may not as clean as the data for Retailer X. As a result of the aggregation, some of the cross-price coefficient estimates do not have expected signs.

The coefficient estimates for the four retail promotional tactic variables are positive, indicating these promotional activities had positive impacts on consumers' marginal utilities for the products studied. However, the estimate for TPRs was statistically not different from zero, i.e., TPRs had no additional advertising impacts on the gallon sales of the OJ brands studied (TPRs did impact demand, however through prices). The magnitudes of the promotional activity parameters show that feature ads and displays had the highest impact on OJ demand, which is followed by displays only, and feature ads only, TPRs had the least impact.

Because the estimate for TPRs is statistically not different from zero, this retail promotional tactic will not be discussed further. The impacts of a ten %ACV points increase in the rest three promotional tactics, i.e., feature ad only, displays only, and feature ad and displays, evaluated at sample means, are presented in Table 2.

Results indicate that promotional activities increased the demand for the brand/product being promoted; therefore, there is an incentive for brand owners to promote their products using TPR, feature ads, and displays. Retail promotions often come with price reductions. As shown in this study, price reductions or increases could result in positive or negative revenue gains depending on consumers' responses to these price changes. Whether a retailer can benefit from these promotional activities depends on the type of promotion, the brand being promoted, and whether there is a price reduction. Results show that the combination of feature ads and displays had the largest impacts on retail revenue among the four promotional tactics studied and temporary price reduction had no advertising impact on retail revenue. Results also show that when Retailer X promotes an OJ brand using any of the tactics examined in this study, a larger portion of the increased demand for promoted brand comes from reduced demand for Other Brand OJ sold by Retailer X and a smaller portion comes from the decreased demand in Retailer X's competing stores in the same trading area.

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Table 1. Parameter estimates

	μ_i	Retailer X					X COMP				
		MM	Trop	FN	PL	Other	MM	Trop	FN	PL	Other
						Slutsky Coefficient (π_{ij})					
MM	0.3613*	-0.4627*	0.1238*	0.1124*	0.0350*	0.0159*	0.0197*	0.0769*	0.0203*	0.0775*	-0.0188*
	(0.0378)	(0.0320)	(0.0122)	(0.0217)	(0.0179)	(0.0069)	(0.0095)	(0.0152)	(0.0078)	(0.0122)	(0.0105)
Tropicana	0.2709*		-0.4610*	0.1175*	0.0954*	0.0212*	0.0272*	0.0453*	0.0089*	0.0414*	-0.0197*
	(0.0390)		(0.0166)	(0.0129)	(0.0124)	(0.0032)	(0.0046)	(0.0080)	(0.0037)	(0.0071)	(0.0056)
FN	0.0338			-0.4079*	0.0690*	0.0186*	0.0170*	0.0443*	0.0115**	0.0041	0.0134
	(0.0430)			(0.0323)	(0.0188)	(0.0067)	(0.0098)	(0.0157)	(0.0077)	(0.0126)	(0.0103)
PL	-0.0990*				-0.2462*	0.0206*	0.0009	0.0315*	-0.0102**	-0.0117	0.0156*
	(0.0469)				(0.0236)	(0.0059)	(0.0077)	(0.0096)	(0.0061)	(0.0110)	(0.0081)
Other	0.0140**					-0.0947*	0.0065	0.0089	0.0012	0.0027	-0.0008
	(0.0089)					(0.0098)	(0.0054)	(0.0058)	(0.0042)	(0.0040)	(0.0060)
MM	0.1132*						-0.1287*	0.0239*	0.0132*	0.0134*	0.0069
	(0.0144)						(0.0087)	(0.0073)	(0.0048)	(0.0058)	(0.0071)
Tropicana	0.1478*							-0.3202*	0.0454*	0.0295*	0.0144
	(0.0257)							(0.0193)	(0.0066)	(0.0082)	(0.0106)
FN	0.0406*								-0.1105*	0.0079*	0.0124*
	(0.0114)								(0.0062)	(0.0046)	(0.0055)
PL	0.1893*									-0.1742*	0.0093**
	(0.0242)									(0.0110)	(0.0067)
Other	-0.0718*										-0.0327*
	(0.0167)										(0.0160)
TPR	0.000012										
	(0.00007)										
Feature	0.0004*										
	(0.0001)										
Displays	0.0013*										
	(0.0007)										
F&D	0.0040*										
	(0.0008)										

The numbers in parentheses are standard errors of the estimates.

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

Table 2. Estimated revenue impacts of retail promotional tactics from a 10 point increase in %ACV

	In Retailer X					In X COMP				
	MM	Trop	FN	PL	Other	MM	Trop	FN	PL	Other
					Feature Ads					
MM	8,279	-2,233	-2,029	-619	-281	-348	-1,362	-361	-1,395	328
Tropicana	-2,214	8,320	-2,121	-1,689	-375	-478	-802	-159	-745	343
FN	-2,012	-2,121	7,363	-1,221	-328	-300	-785	-205	-74	-234
PL	-626	-1,722	-1,246	4,357	-364	-16	-557	181	210	-272
Other	-285	-383	-335	-365	1,672	-114	-157	-21	-49	14
MM*	-353	-490	-307	-16	-114	2,267	-424	-235	-241	-119
Tropicana*	-1,376	-818	-800	-557	-157	-422	5,670	-810	-531	-251
FN*	-362	-161	-208	180	-20	-232	-804	1,972	-142	-77
PL*	-1,387	-747	-74	207	-48	-236	-523	-140	3,133	-162
Other*	337	355	-243	-276	14	-121	-255	-221	-168	570
Gain	3,142	1,861	1,632	463	325	1,256	3,664	565	2,052	-39
					Displays					
MM	29,440	-7,942	-7,216	-2,202	-998	-1,237	-4,842	-1,285	-4,960	1,165
Tropicana	-7,874	29,587	-7,544	-6,006	-1,332	-1,701	-2,852	-565	-2,649	1,219
FN	-7,153	-7,542	26,182	-4,342	-1,165	-1,066	-2,792	-730	-262	-833
PL	-2,226	-6,125	-4,429	15,492	-1,293	-57	-1,982	644	747	-965
Other	-1,012	-1,362	-1,191	-1,296	5,945	-406	-558	-73	-173	48
MM*	-1,256	-1,743	-1,093	-57	-407	8,061	-1,508	-836	-857	-425
Tropicana*	-4,893	-2,907	-2,846	-1,981	-557	-1,500	20,162	-2,882	-1,890	-892
FN*	-1,288	-572	-738	639	-72	-826	-2,861	7,011	-504	-273
PL*	-4,933	-2,657	-262	735	-169	-839	-1,860	-500	11,143	-578
Other*	1,197	1,262	-863	-981	49	-429	-907	-785	-597	2,027
Gain	11,175	6,616	5,802	1,645	1,157	4,467	13,027	2,008	7,296	-140
					Feature Ads and Displays					
MM	92,496	-24,952	-22,672	-6,918	-3,137	-3,886	-15,214	-4,036	-15,585	3,661
Tropicana	-24,739	92,957	-23,701	-18,871	-4,185	-5,346	-8,962	-1,775	-8,322	3,829
FN	-22,474	-23,697	82,261	-13,643	-3,659	-3,350	-8,772	-2,292	-822	-2,616
PL	-6,994	-19,243	-13,915	48,674	-4,063	-178	-6,228	2,024	2,348	-3,033
Other	-3,180	-4,278	-3,742	-4,073	18,678	-1,275	-1,755	-230	-542	151
MM*	-3,947	-5,476	-3,433	-179	-1,278	25,327	-4,737	-2,628	-2,691	-1,334
Tropicana*	-15,374	-9,134	-8,942	-6,225	-1,749	-4,713	63,347	-9,055	-5,937	-2,802
FN*	-4,048	-1,796	-2,319	2,008	-228	-2,595	-8,988	22,027	-1,583	-856
PL*	-15,500	-8,347	-824	2,310	-532	-2,635	-5,843	-1,570	35,008	-1,815
Other*	3,760	3,967	-2,711	-3,082	153	-1,349	-2,849	-2,465	-1,874	6,368
Net Gain	35,109	20,787	18,230	5,168	3,634	14,035	40,930	6,309	22,922	-440
% Net Gain	38.0%	22.4%	22.2%	10.6%	19.5%	55.4%	64.6%	28.6%	65.5%	-31.3%

*OJ brands in X COMP.