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COUPON IMPACTS ON ORANGE JUICE DEMAND BASED ON TIME-SERIES AND CROSS-SECTIONAL DATA

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This paper examines the impacts of coupon programs on the retail demand for orange juice (OJ). Coupons can be viewed as impacting OJ gallon sales through 1) a price reduction and 2) a demand shift. Redeeming a coupon results in a lower price by the amount of the discount or rebate provided; additionally, consumer preferences for the product may be positively impacted by being exposed to the coupon through an informational/advertisement effect. This study focuses on the demand shift effect, as the price data used in the analysis were a weighted average of discounted and regular prices paid by coupon users and nonusers, respectively.

Nielsen sales data for grocery stores that do $2 million or greater business annually for the period from week ending 2/02/08 through 5/15/10 (120 weekly observations) were studied. The data are by market, covering 52 cities and the rest of the United States, resulting in a total of 6,360 observations (53 times 120).

The data studied reflect the extent of coupon usage as opposed to intensity, indicating whether coupons are being used in a store to purchase some product in the OJ category. The number of products sold with coupons or the savings, however, are unknown. Despite this limitation, the results of the study indicate the extent of coup has a demand impact.

Model

The log of OJ gallon sales was specified as a function of 1) the level of OJ coupons, 2) the level of OJ promotions, which includes in-store features, displays, features and displays together, and temporary price reductions, 3) the same in-store promotions for a selected group of substitutes, 4) the log of the price of OJ, 5) the log of the price for the substitute group, 6) and the unemployment rate. OJ coupons were measured by the percent of all commodity volume (ACV) where coupons were used. Each OJ promotional variable was measured as the share of total OJ dollar sales on that promotion. The promotional variables for the substitute group were measured in the same manner. The substitute group included six products---OJ drinks, OJ blends, OJ blend drinks, grapefruit juice, GJ cocktail, and GJ blends. All except the unemployment variable were directly obtained or constructed from data provided by Nielsen. The unemployment variable, which is intended to reflect the constrained income situation faced by many households as a result of U.S. economic crisis, was obtained from the U.S. Department of Labor. The reported unemployment rate varies across nine regions; and the unemployment rate for a city was that for the associated region. The overall U.S. unemployment rate was used for the market representing the rest of the U.S.

The fixed effects, cross-section, time-series model was used in the analysis. It is assumed that the model's intercept varies across city and time, but the coefficients on the other variables are the same across these two dimensions. Formally, the demand for OJ by city, by week is specified as

(1) $\log q_{ct} = \mu_c + \gamma_t + \beta_1 coup_{ct} + \beta_2 promo_{ct} + \beta_3 promos_{ct} + \beta_4 \log p_{ct} + \beta_5 \log ps_{ct} + \beta_6 unem_{ct}, + \varepsilon c_t$

where subscripts c and t stand for the city and week, respectively; q is OJ gallons; coup is the ACV for OJ coupons; promo and promos are promotional variables for OJ and the group of six substitutes, respectively; p and ps are prices for OJ and the competitive products, respectively, unem is the unemployment rate; and ε_{ct} is an error term. The coefficients β_1, β_2, β_3, and β_6 indicate percentage changes in demand for unit changes in the associated variables, while β_4 and β_5 are own and cross price elasticities of demand, indicating percentage changes in demand for one percent changes in prices. The coefficient μ_c indicates a city specific effect. Cities have different populations and perhaps preferences based on the demographic background of its population, all of which likely influence μ_c. Since the time period analyzed is relatively short, population and preferences are treated as constant for a city, and it is assumed that the coefficient μ_c is constant over the weeks studied. The coefficient γ_t indicates a time specific effect: over time demand may change due to seasonality, generic and brand OJ advertising across all cities, changes in competitive product prices and advertising levels not included in the model and other factors. The city and time coefficients may also reflect consumer income effects across cities and time, not captured by the unemployment rate.

The model was estimated using the Parks method which allows the error terms to be contemporaneously correlated across cities, and follow city-specific first-order autocorrelation processes--- $E(\varepsilon^2_{ct}) = \sigma_{cc}$ (heteroscedasticity), $E(\varepsilon_{ct}\, \varepsilon_{jt}) = \sigma_{cj}$ (contemporaneous correlation), and $\varepsilon_{ct} = \rho_c \varepsilon_{ct-1} + \nu_{ct}$ (autocorrelation).

Model Estimates

Descriptive statistics across all cities and weeks are provided in Table 1. The mean coupon usage was 3.3%, with a range of zero to 91.0%. The coupon variable measures the extent, but not intensity, of usage. For example, the coupon ACV percentage in a given week for a city where coupons for one OJ product only are used could be the same as that for the same city but another week where coupons for multiple products are used.

Table 2 shows the model estimates. The estimates for the large number of dummy variables are omitted to save space. Two set of estimates are provided---estimates based on the ordinary least squares (OLS) and Parks methods. All coefficient estimates for both methods, except those for the promotion of substitutes, had the correct sign and were statistically significant at $\alpha = 10\%$ level. The coefficients for OJ coupons and promotions were positive; the own price and cross price elasticity estimates were negative and positive, respectively; and the coefficient on the unemployment rate was negative.

Although there is general consistency in the OLS and Parks estimates with respect to sign and statistical significance, there are notable differences in the two sets of estimates. For example, the OLS and Parks coupon coefficient estimates were .0002 and .0006, respectively. Similar differences in the OLS and Parks coefficients for the other variables also exist. Thus, the

relatively large differences in estimates indicate that the less restrictive treatment of the error term in the Parks model was important.

The Parks coupon coefficient estimate indicates that a store where OJ coupons are used should see a 6% increase in OJ gallon sales (.0006 times 100), indicating the demand shift impact of coupons is significant. A recent study by Dong and Leibtag also found the coupon informational/advertising effect was relatively large for fruit and vegetable consumption.

Although the results of this study suggest that the extent of coupons usage is important in increasing OJ sales, they leave open the question of the impact of coupon intensity. This issue can be examined in part by considering the coupon impacts for more narrowly defined OJ product groups. The demand equations for four OJ branded product groups, as well as for a private label/generic OJ group, were thus estimated (Table 3). Focusing on the Parks results, the own coupon coefficients for the individual brands (Table 3) are 2.1 to 5.5 times larger than the estimate for the OJ group (Table 2). To some extent, these differences may reflect intensity, but they may also reflect the greater substitution between more narrowly defined product categories. Thus, although these results provide some indication of the importance of intensity, they do not address this issue completely.

Conclusions

A recent study by Dong and Leibtag found coupons were effective in increasing fruit and vegetable demand. The current study supports these finding for the OJ product group. The analysis focused on the informational/advertising or demand shift impact of coupons, as opposed to the price impact which could not be determined since data on prices were a weighted average for coupon users and non-users. The results indicate a 6% increase in OJ gallons sales when coupons are used. The coupon variable used in the analysis, however, measures the extent of coupon usage but not intensity. As such, the results provide a partial view of the impact of coupons and further analysis on data that also includes some measure of intensity is needed to more fully evaluate this marketing tool.

References

Dong, D,.and E. Leibtag. *Promoting Fruit and Vegetable Consumption: Are Coupons More Effective Than Pure Price Discounts?* Economic Research Report No. 96, U.S. Dept. of Agriculture, Economic Research Service, June 2010.

Parks, R. "Efficient Estimation of a System of Regression Equations When Disturbances Are Both Serially and Contemporaneously Correlated." Journal of the American Statistical Association, 62, 1967, pp. 500-509.

Table 1. Descriptive Statistics

Variable	Mean	Std Dev	Minimum	Maximum
OJ Ga. Sales (Week)	174,089	233,292	26,240	1,828,240
OJ Coupon (%)	3.320	9.571	0.00	91.00
OJ Promo (%)	0.426	0.109	0.06	0.77
Subst. Promo (%)	0.396	0.101	0.10	0.76
OJ Price ($/Ga.)	5.638	0.575	3.42	7.65
Subst. Price ($/Ga.)	3.977	0.658	1.98	5.78
Unemploy. Rate (%)	7.880	2.188	3.800	12.400

Table 2. Time Series & Cross Section Regression Estimates for
OJ Gallon Sales, Nielsen Stores Doing $2 Million Plus Business.

Variable	Coeff. Est.	t Value	Pr > |t|
OLS*			
OJ Coupon	0.0002	2.84	0.005
OJ Promo	0.1126	9.78	<.0001
Subst. Promo	-0.0135	-1.28	0.202
Log OJ Price	-1.1667	-82.19	<.0001
Log Subst. Price	0.0773	6.44	<.0001
Unemploy. Rate	-0.2899	-1.79	0.073
Parks Method**			
OJ Coupon	0.0006	12.8200	<.000
OJ Promo	0.2878	37.0700	<.0001
Subst. Promo	-0.0084	-1.2700	0.203
Log OJ Price	-1.0685	-103.3000	<.0001
Log Subst. Price	0.0209	2.7400	0.006
Unemploy. Rate	-1.5273	-9.7900	<.0001
*R^2		0.996	
**R^2		0.789	

Table 3. Time Series, Cross Section Regression Estimates for Selected OJ Brand Gallon Sales, Nielsen Stores Doing $2 Million Plus Business.

	Brand 1		Brand 2		Brand 3		Brand 4		Brand 5	
	Coeff. Est.	Pr > |t|	Coeff. Est.	Pr > |t|	Coeff. Est.	Pr > |t|	Coeff. Est.	Pr > |t|	Coeff. Est.	Pr > |t|
OLS*										
Brand 1 OJ Coupon	0.001	0.134	-0.001	0.008	0.001	0.088	0.001	0.131	0.000	0.402
Brand 2 OJ Coupon	-0.001	0.090	0.002	<.0001	-0.001	0.010	-0.001	0.077	0.000	0.217
Brand 3 OJ Coupon	0.001	0.044	0.000	0.471	0.000	0.162	0.000	0.791	0.000	0.332
Brand 4 OJ Coupon	-0.003	<.0001	0.000	0.372	-0.001	0.048	0.000	0.541	-0.001	0.079
Brand 5 OJ Coupon	-0.001	0.020	0.000	0.884	0.000	0.286	0.001	0.037	0.002	<.0001
Brand 1 OJ Promo	0.500	<.0001	-0.039	<.0001	-0.041	<.0001	0.038	0.000	-0.016	0.052
Brand 2 OJ Promo	-0.175	<.0001	0.418	<.0001	-0.084	<.0001	0.085	<.0001	-0.025	0.039
Brand 3 OJ Promo	-0.195	<.0001	-0.079	<.0001	0.379	<.0001	-0.034	0.024	-0.016	0.157
Brand 4 OJ Promo	0.013	0.568	-0.056	<.0001	-0.049	<.0001	0.325	<.0001	-0.097	<.0001
Brand 5 OJ Promo	-0.085	<.0001	-0.031	0.000	-0.041	<.0001	0.005	0.729	0.143	<.0001
Subst. Promo	-0.213	<.0001	-0.063	0.000	0.000	0.988	-0.007	0.813	-0.002	0.939
Log Brand 1 Price	-2.686	<.0001	0.143	<.0001	0.202	<.0001	0.172	<.0001	0.239	<.0001
Log Brand 2 Price	0.450	<.0001	-1.973	<.0001	0.262	<.0001	0.489	<.0001	0.331	<.0001
Log Brand 3 Price	0.698	<.0001	0.248	<.0001	-1.837	<.0001	-0.016	0.728	0.524	<.0001
Log Brand 4 Price	0.045	0.081	-0.015	0.209	-0.010	0.437	-1.778	<.0001	-0.012	0.436
Log Brand 5 Price	0.010	0.732	0.096	<.0001	0.066	<.0001	0.136	<.0001	-1.481	<.0001
Log Subst. Price	-0.162	0.000	0.054	0.006	0.140	<.0001	0.116	0.000	0.109	<.0001
Unemploy. Rate	-2.708	<.0001	-1.009	0.000	0.705	0.013	-3.012	<.0001	4.186	<.0001

Table 3 continued Parks Method**										
Brand 1 OJ Coupon	0.003	<.0001	0.000	0.609	0.000	0.236	0.001	0.009	0.000	0.253
Brand 2 OJ Coupon	0.000	0.863	0.001	<.0001	0.000	0.891	0.001	0.099	0.000	0.844
Brand 3 OJ Coupon	0.001	0.002	0.001	<.0001	0.000	0.132	0.001	0.026	0.001	0.016
Brand 4 OJ Coupon	0.000	0.443	0.000	0.518	0.000	0.607	0.002	<.0001	0.000	0.092
Brand 5 OJ Coupon	0.001	0.014	0.000	0.010	0.000	0.132	0.000	0.265	0.001	<.0001
Brand 1 OJ Promo	0.683	<.0001	-0.008	0.139	-0.018	0.001	0.028	<.0001	-0.028	<.0001
Brand 2 OJ Promo	-0.088	<.0001	0.494	<.0001	-0.043	<.0001	0.060	<.0001	0.002	0.848
Brand 3 OJ Promo	-0.091	<.0001	0.024	0.003	0.422	<.0001	0.054	<.0001	-0.012	0.124
Brand 4 OJ Promo	0.263	<.0001	0.155	<.0001	0.075	<.0001	0.504	<.0001	0.066	<.0001
Brand 5 OJ Promo	-0.023	0.086	-0.004	0.522	-0.009	0.209	0.001	0.879	0.233	<.0001
Subst. Promo	0.080	0.004	-0.046	0.002	0.203	<.0001	-0.001	0.932	-0.062	<.0001
Log Brand 1 Price	-2.215	<.0001	0.172	<.0001	0.121	<.0001	0.175	<.0001	0.124	<.0001
Log Brand 2 Price	0.571	<.0001	-1.852	<.0001	0.149	<.0001	0.311	<.0001	0.331	<.0001
Log Brand 3 Price	0.856	<.0001	0.403	<.0001	-1.915	<.0001	0.242	<.0001	0.423	<.0001
Log Brand 4 Price	0.498	<.0001	0.308	<.0001	0.170	<.0001	-1.532	<.0001	0.218	<.0001
Log Brand 5 Price	0.137	<.0001	0.095	<.0001	0.107	<.0001	0.094	<.0001	-1.491	<.0001
Log Subst. Price	0.573	<.0001	-0.074	<.0001	0.521	<.0001	0.043	0.034	0.000	0.999
Unemploy. Rate	4.023	<.0001	1.103	<.0001	-3.521	<.0001	-0.853	0.003	0.683	0.004
*R^2	0.978		0.991		0.994		0.979		0.983	
**R^2	0.880		0.862		0.886		0.913		0.858	