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THE IMPACT OF FLU/COLD INCIDENTS AND RETAIL OJ PROMOTION ON OJ DEMAND

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Introduction

This paper discusses a study of orange juice (OJ) demand. To provide background for this study, an overview of the current OJ situation including discussion on advertising and promotion in the OJ industry is provided below.

Relatively low consumer demand for orange juice in the United States and Europe underlies the current OJ situation. Based on a USDA GAIN report (Hammond and Wiggin 2008), European demand for OJ is declining apparently due to preference shifts to exotic fruit juices. U.S. demand is down due to relatively high retail prices, reduced real income levels for many consumers, and reduced retail promotions measured by the percentage of gallons sold on deals (store features, displays and price discounts). The slow down in the U.S. economy, along with increased prices for gas, foods and other goods, means many consumers have less to spend on items such as OJ. Reduced European demand tends to result in reductions in their OJ imports, largely from Brazil, leaving more product to be allocated (at lower prices) to other world markets including the United States. Brazil thus continues to have a large influence on OJ prices in the world market, and this influence impacts OJ prices in the US and ultimately the price of Florida oranges. Note that OJ production in Florida accounted for over 95% of the U.S. OJ production and over 95% of Florida's oranges were processed into OJ in the 2007-08 season.

Retail sales of orange juice have reacted to the higher prices, as well as reduced retail promotions, the slowdown in the economy and higher prices for gas and other goods. A continuing issue is the need to maintain and grow demand for Florida orange

juice. Recent declines in demand caused by low-carb diets and the continued proliferation of competing beverages put Florida citrus growers at risk of losing their market share. Generic marketing efforts by the Florida citrus industry and retail promotions represent means to support market growth providing a profitable outlet for Florida orange juice.

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 promotions being major and others being relatively minor (line ads).

In-store promotional displays include the display of products in secondary locations, cut cases placed next to regular shelf locations, and those displays in primary locations but with special efforts. Displays give the product of interest more visibility and may increase its sales. 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 this occurs, additional price effects on the sales of the products of interest could occur. Moreover, an advertised price reduction itself may have a separate advertising effect on a product's demand. Generally, increased sales 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.

Past research indicates that retail promotions have had positive impacts on the demand for orange juice (Brown and Lee 2007; Lee, Brown, and Chung 2009); vitamin C plays some role in respiratory defense mechanisms; and regular vitamin C supplementation is associated with a reduction in the duration and severity of common cold symptoms (Karlowski et al. 1975; Anderson et al. 1975; Dick et al. 1990). Lee (2007) found that orange juice is the top beverage that provides vitamin C in America's diet. The purpose of the present study is to examine whether there is a relationship between the incidence of the flu and colds, and the demand for orange juice; and whether retail promotions are more effective in selling orange juice during peak flu/cold periods than off-peak periods.

The rationale that underlies the research is that a better understanding of consumer reactions to retail OJ promotions during flu/cold periods will provide useful information for the FDOC and retailers to promote OJ more efficiently. This information about consumer reactions to retail promotions during flu/cold periods is intended to aid the FDOC and retailers in determining the appropriate timing to promote orange juice, in order to ultimately increase orange juice demand, and improve Florida orange growers' revenue and profitability. Developing an understanding of the relations among retail promotions, the incidents of flu and colds and orange juice demand is intend to help FDOC field representatives better assist retailers in promoting orange juice more efficiently.

Data and Approach

In this study, we assume that the demand for OJ is a function of its own-price, competing beverage prices, income, retail promotions, and the intensity of the flu and/or colds. Formally, the relationship can be written as

(1) $q_t = q_t(p_t, Inc_t, Prom_t, Flu_t)$

where subscript *t* indicates a time period (week); q_t is the per capita OJ purchase in period *t*; Inc_t is per capita personal disposable income; and p_t, $Prom_t$, and Flu_t are vectors of prices, retail promotions, and flu/cold intensity measures, respectively. Model (1) was estimated using both linear and double-log functional forms. In the linear model, cross-product terms between retail promotions and flu/cold intensity measures were included to examine if retail promotions are more effective in increasing OJ demand during flu/cold seasons; i.e.,

(2) $q_t = \alpha_0 + \Sigma_j \beta_j p_{jt} + \alpha_1 Inc_t + \Sigma_k \gamma_k Prom_{kt} + \alpha_2 Flu_t + \Sigma_k \pi_k Prom_{kt} Flu_t + \varepsilon_t$

Two econometric models were used to estimate the effectiveness of retail promotions during the flu/cold season on the demand for OJ. One of the econometric models estimates the OJ demand relationship in the U.S. using equation (1); and the other estimates the OJ demand relationship in the 52 Nielsen markets in the U.S. using time-series and cross-section pooling techniques with the following specification

(2') $q_{it} = \alpha_0 + \Sigma_j \beta_j p_{jit} + \Sigma_k \gamma_k Prom_{kit} + \alpha_2 Flu_{it} + \Sigma_k \pi_k Prom_{kit} Flu_{it} + \varepsilon_{it}.$

The subscript *i* denotes the ith market. Note that past study (Brown and Lee 1992) showed that there are inventory effects in juice demand. An increase in flu/cold incidents may increase the demand for OJ and the effectiveness of retail promotions; however, the increased purchase in one time period may affect (decrease) the quantity of

OJ purchased in the next time period. To capture the flu/cold inventory impact on OJ demand, if there is any, equation (2') can be rewritten by adding lagged flu/cold incident variable and the flu/cold and retail promotion cross-product terms as

$$(2'') \quad q_{it} = \alpha_0 + \Sigma_j \beta_j p_{jit} + \Sigma_k \gamma_k \text{Prom}_{kit} + \alpha_2 \text{Flu}_{it}$$

$$+ \Sigma_k \pi_k \text{Prom}_{kit} \text{Flu}_{it} + \alpha_3 \text{Flu}_{it-1} + \Sigma_k \pi'_k \text{Prom}_{kit} \text{Flu}_{it-1} + \varepsilon_{it}.$$

In general, income, population composition, other demographic characteristics, and diet habits are expected to differ across markets in the U.S. and time. There are several approaches that can be used to model the differences in such factors among markets. These approaches include the models proposed by Fuller and Battese; Da Silva; Mundlak, and Parks.

Given the OJ sales of the 52 Nielsen markets are measured at common points in time and they are all U.S. markets, it is likely that the errors in the demand equations are related. However, since these markets are different in size and population composition, we expect that the error terms of these markets are correlated and have different variances. Past research suggests that weekly demand for orange juice has a relatively strong inventory effects (Brown and Lee 1992). In addition, a study of a conditional juice demand was found that conditional expenditures and prices can be treated as exogenous (Brown, Behr, and Lee 1994). Therefore, the approach proposed by Parks was used. Parks' approach assumes that the disturbance for each market follows an AR(1) process and also that comtemporaneous correlation exists. Market-specific persistence in consumption related to preferences as well as other factors is allowed through an autoregressive term. Formally, the error structure can be written as

(3) $E(\varepsilon_{it}^2) = \sigma_{ii}$ (heteroskedasticity)

        $E(\varepsilon_{it}\varepsilon_{jt}) = \sigma_{ij}$ (contemperanously correlated)

        $\varepsilon_{it} = \rho_i\, \varepsilon_{it-1} + \upsilon_{it},$ (autoregression)

where

(4) $E(\upsilon_{it}) = 0$; $E(\upsilon_{it-1}\upsilon_{jt}) = 0$; $E(\upsilon_{it}\upsilon_{jt}) = \varphi_{ij}$; $E(\upsilon_{it}\upsilon_{is}) = 0$ for $s \neq t$; $E(\upsilon_{0t}) = 0$; and

        $E(\upsilon_{i0}\upsilon_{j0}) = \sigma_{ij} = \varphi_{ij}/(1 - \rho_i\, \rho_j)$

Equations (2) and (2') with error terms having the structure specified in (3) and (4) were estimated using weekly Nielsen ScanTrack OJ sales data and the Surveillance Data Inc. (SDI), flu/cold intensity measure for the period from 4/22/06 through 8/02/08.

Two data sets were created for this study. For equation (2), the weekly total orange juice sales in grocery stores with annual sales of over $2 million in the U.S. were used. For equations (2') and (2"), the weekly total orange juice sales in grocery stores with annual sales of over $2 million in the 52 Nielsen markets were used. The SDI data include statistics on flu/cold/respiratory illness incidents (symptoms include cough, fever, ear ache, nasal congestion, and sore throat) collected each week from over thousands of healthcare providers across the U.S. In equation (2), the sum of the flu incidents across the 135 SDI markets were used. In equations (2') and (2"), flu incidents of the 135 SDI markets were aggregated into the 52 Nielsen markets according to the geographic areas covered by the Nielsen markets.

The retailers' promotional variables used in this study are the percent of OJ sold using four different retail promotional tactics. These promotional tactics are features without displays, displays without features, displays and features, and temporary price reductions. Prices included in the study are those for orange juice, grapefruit juice,

orange juice blends, grapefruit juice blends, orange juice drinks, orange juice blend drinks, and grapefruit juice cocktail. A time trend variable was used in model represented by equation (2) instead of the income variable to capture income and other factors that were not included in the model (income and time trend are highly collinear). To capture the seasonal pattern in OJ consumption, we included a sine (Season 1) and a cosine (Season 2) variable (Brown, 2008). Sample statistics for the market level data are presented in Table 1. Over the study period, grapefruit juice had the highest price among the juices/drinks examined, followed by the prices of grapefruit juice blends, grapefruit juice cocktail, orange juice blends, 100% orange juice, less than 100% orange juice drinks, and orange juice blend drinks. About 20% of the orange juice was sold on feature ads without display; 17% on temporary price reductions; 5% on feature ads and display; and 2% on displays without feature ads. Reported U.S. Flu/cold incidents averaged at about 300,000 per week with a relatively large standard deviation.

Results

When estimating model (2) using ordinary least squares (OLS) method, a serious multicollinearity problem was encountered rendering the coefficient estimates unreliable. The simple correlation coefficients between the flu/cold variable and the cross-product terms between flu/cold and retail promotional variables for the total U.S. are very high and statistically significant (Table 2); at the market level, the correlation coefficients are a little better than those found at the total U.S. market. Given this problem, the cross-product terms between flu/cold variable and retail promotional variables were deleted from model (2); model estimates for this specification are shown in Table 3. Nevertheless, multicollinearity was still evident. As shown in Table 2, although the R^2

value is 0.9276, most coefficient estimates are not different from zero. The condition index (Belsley, Kuh, and Welsch 1980) has a value of 704.57. According to Belsley et al., when this number is around 10, weak dependencies may be affecting the regression estimates and when it is larger than 100, the estimates may have a fair amount of numerical error. Regardless these results, given the purpose of this study is to examine if flu/cold enhances retail promotions, exclusion of the cross-product terms between flu/cold and promotional variables means the results cannot be used for this purpose.

The Parks method was used to estimate (2') and (2"); results are shown in Tables 4 and 5, respectively. The R^2 measure was calculated using the goodness-of-fit measure reported by Buse. Results shown in tables 4 and 5 indicate that lagged flu/cold had an inventory effect on the demand for OJ and the coefficients of cross-product terms of lagged flu/cold variable and retail promotions are all negative and statistically different from zero. In the following discussion, only the results presented in Table 5 are used.

Coefficient estimates shown in Table 5 indicate that grapefruit juice and orange juice drinks are substitutes of (100%) orange juice, while orange juice blends, grapefruit juice blends, and orange juice blend drinks are complements of orange juice. All coefficient estimates for retail promotional tactics are positive and statistically different from zero except the one for features without displays. Ignoring the interaction terms, the results show that features and displays had the largest impact on OJ demand, followed by the impacts of displays only and temporary price reduction.

The coefficient estimate for the flu/cold variable for the current week by itself is positive; however, it is not statistically different from zero. The cross-product terms between the flu/cold variable and retail promotional tactics are all positive and

statistically different from zero; indicating that the number of flu/cold incidents increased the effectiveness of retail promotional activities. Results indicate that every additional thousand flu/cold incidents reported increased the impacts of retail promotional activities on OJ sales by 2.3, 2.8, 2.0 and 0.9 gallons, respectively, for features only, displays only, features and displays, and temporary price reductions, respectively. The lagged flu/cold effects show that for every additional thousand flu/cold incidents reported decreased the demand for OJ by 5.6 gallons and also reduced the impact of retail promotions by 0.2, 0.5, 0.4, and 0.1 gallon for features only, displays only, features and displays, and temporary price reductions, respectively. The net impact of flu/cold, i.e., the sum of the coefficients of the current and lagged flu/cold variables and their cross-product terms with retail promotions, is 3.5 gallons for each additional flu/cold incidents reported. Results shown in Table 5 suggest that retail promotions during the peak flu/cold season have additional impacts on OJ demand. Flu/cold incidents had no current impacts on the demand for OJ unless there were accompanied by retail promotions; however, lagged flu/cold had an inventory effect on the demand for OJ and reduced the effectiveness of retail promotions.

The coefficients for seasonal dummies indicate there was a season pattern in the demand for orange juice. The demand elasticities of prices, promotional tactics, and flu/cold can be estimated, respectively; as

$(\partial q / \partial p_j)(p_j/q) = \beta_j(p_j/q);$

$(\partial q / \partial Prom_k)(Prom_k/q) = (\gamma_k + \pi_k \, Flu_t + \pi_k' Flu_{t-1})(Prom_k/q);$

$(\partial q / \partial Flu_t)(Flu_t/q) = (\alpha_2 + (\Sigma_k \, \pi_k \, Prom_k))(Flu_t/q);$ and

$(\partial q / \partial Flu_{t-1})(Flu_{t-1}/q) = (\alpha_3 + (\Sigma_k \, \pi_k' \, Prom_k))(Flu_{t-1}/q);$

Demand elasticity estimates calculated at sample means are presented in the last column in Table 5. In general, elasticity estimates are in the expected range, i.e., the own-price elasticity less than unity in absolute value (inelastic) and low cross-price elasticities. Retail promotion and flu/cold elasticity estimates are small. Displays only had the highest demand elasticity, followed by those for features and displays, displays only, and temporary price reductions.

Concluding Remarks

In this study, we examined the impacts of retail promotions and flu/cold incidents on the demand for orange juice using weekly Nielsen grocery OJ sales and data on flu/cold incidents reported by SDI. The cross-section time-series pooling technique proposed by Parks was used to estimate the demand parameters. Results show that current flu/cold incidents alone had no significant impacts on OJ sales; however, they increased the effectiveness of retail promotions on the demand for OJ. The lagged flu/cold incidents had a negative impact on the demand for OJ and reduced the effectiveness of retail promotions. The net impact of flu/cold on the demand for OJ is positive. Therefore, Florida citrus growers should encourage retailers to use this tactic during the cold/flu seasons to promote OJ.

Table 1. Sample statistics –market level data

Variable	Mean	Std Dev
Gallons Sold (1,000) – Market Level	154.64	133.94
Average Prices		
Orange Juice	5.67	0.66
Grapefruit Juice	6.62	0.58
Orange Juice Blends	5.73	0.52
Grapefruit Juice Blends	6.47	0.94
Grapefruit Juice Cocktail	5.79	0.69
Orange Juice Drinks	3.55	0.65
Orange Juice Blend Drinks	2.89	0.58
Retail Tactics (% of Total Gallons)		
Feature Ads w/o Display	19.66	8.98
Display w/o Feature Ads	2.41	2.23
Feature Ads and Display	4.74	4.19
Temporary Price Reduction	16.95	7.14
Flu/cold (1,000) – Market Level	292.89	337.95

Table 2. Simple correlation coefficients

	Flu/Cold	Cross-Product of Flu/Cold and			
		Feature	Displays	Feature & Display	Price Reduction
			U.S.		
Flu/Cold	1.000				
Cross-Product of Flu/Cold and					
Feature	0.945	1.000			
	<.0001*				
Displays	0.886	0.777	1.000		
	<.0001	<.0001			
Feature & Display	0.910	0.892	0.861	1.000	
	<.0001	<.0001	<.0001		
Price Reduction	0.968	0.908	0.870	0.853	1.000
	<.0001	<.0001	<.0001	<.0001	
			Market Level		
Flu/Cold	1.000				
Cross-Product of Flu/Cold and Feature	0.902	1.000			
	<.0001				
Displays	0.395	0.219	1.000		
	<.0001	<.0001			
Feature & Display	0.707	0.673	0.619	1.000	
	<.0001	<.0001	<.0001		
Price Reduction	0.911	0.743	0.479	0.649	1.000
	<.0001	<.0001	<.0001	<.0001	

*Prob > |r| under H0: $\rho = 0$.

Table 3. Coefficient estimates for equation (2)

Variable	Parameter Estimate	Standard Error
Intercept	17.396*	3.744
Prices ($/Gal)		
OJ	-0.900*	0.177
GJ	-0.340	0.439
OJ Blends	0.239	0.307
GJ Blends	-0.131	0.124
GJ Cocktail	0.045	0.183
OJ Drinks	-0.924*	0.378
OJ Blend Drinks	0.183	0.509
Retail Promotion (%Gal)		
Feature Only	8.376*	1.763
Displays Only	-3.671	9.254
Feature and Displays	-3.840	5.696
Price Reduction	-0.201	1.945
Flu/Cold (MM Incidents)	0.039*	0.014
Season 1	-0.396*	0.158
Season 2	0.032	0.057
Time Trend	-0.005*	0.002
R^2	0.9276	

*Statistically different from zero at α = 0.05 level.
Dependent variable is measured in million gallons per week.

Table 4. Parks' estimates for equation (2')

Variable	Estimate	Standard Error	Elasticity
Intercept	183.0447*	3.3005	
Prices ($/Gal)			
OJ	-15.6533*	0.3778	-0.5741
GJ	0.5393*	0.2715	0.0231
OJ Blends	-1.2212*	0.1954	-0.0453
GJ Blends	-0.2102*	0.1065	-0.0088
GJ Cocktail	-0.0857	0.1467	-0.0032
OJ Drinks	4.6602*	0.2727	0.1071
OJ Blend Drinks	-1.4623*	0.2851	-0.0273
Retail Promotion (%Gal)			
Feature Only	0.0061	0.0145	0.0856
Displays Only	0.2155*	0.0536	0.0158
Feature and Displays	0.2824*	0.0315	0.0279
Price Reduction	0.0819*	0.0169	0.0381
Flu/Cold (000 Incidents)	-0.0035	0.0030	0.1391
Flu Cross-Product w/			
Feature Only	0.0023*	0.0001	
Displays Only	0.0027*	0.0003	
Feature and Displays	0.0021*	0.0002	
Price Reduction	0.0009*	0.0001	
Season 1	0.3854	0.5811	
Season 2	1.4138*	0.6180	
R^2	0.6663		

*Statistically different from zero at α = 0.05 level.
Dependent variable is measured in 1,000 gallons per week.

Table 4. Parks' estimates for equation (2')

Variable	Estimate	Standard Error	Elasticity
Intercept	175.5559*	3.5586	
Prices ($/Gal)			
OJ	-15.1297*	0.4127	-0.5549
GJ	0.6213*	0.2899	0.0266
OJ Blends	-1.4651*	0.2108	-0.0543
GJ Blends	-0.3359*	0.1149	-0.0140
GJ Cocktail	-0.0711	0.1575	-0.0027
OJ Drinks	5.3671*	0.2993	0.1234
OJ Blend Drinks	-1.4418*	0.3015	-0.0270
Retail Promotion (%Gal)			
Feature Only	0.0938*	0.0173	0.0158
Displays Only	0.4154*	0.0660	0.0109
Feature and Displays	0.5068*	0.0404	0.0186
Price Reduction	0.1277*	0.0207	0.0154
Flu/Cold (000 Incidents)	0.0024	0.0032	0.1464
Flu Cross-Product w/	0.0023*	0.0001	
Feature Only	0.0028*	0.0003	
Displays Only	0.0020*	0.0002	
Feature and Displays	0.0009*	0.0001	
Season 1	1.4447*	0.6003	
Season 2	-0.0625	0.6402	
Lagged Flu/Cold	-0.0056*	0.0010	-0.0268
Lagged Flu Cross-Product w/			
Feature Only	-0.0002*	0.0000	
Displays Only	-0.0005*	0.0001	
Feature and Displays	-0.0004*	0.0000	
Price Reduction	-0.0001*	0.0000	
R^2	0.6477		

*Statistically different from zero at $\alpha = 0.05$ level.
Dependent variable is measured in 1,000 gallons per week.

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