# Impacts of Flu/Cold Incidences and Retail Orange Juice Promotion on Orange Juice Demand

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In this study, we examine the impacts of retail promotions and flu/cold incidences on the demand for orange juice using weekly Nielsen grocery orange juice sales statistics and the flu/cold incidences reported by Surveillance Data Inc. The cross-section time-series pooling technique proposed by Parks was used to estimate the demand parameters. Results show that flu/cold incidences increased the effectiveness of retail promotions on the demand for orange juice.

***Key Words:*** retail promotion, flu, cold, orange juice, demand

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 OJ 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). Many consumers have less to spend on items such as OJ as a result of the U.S. economic crisis. 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 United States and ultimately the price of Florida oranges. In the 2007/08 season, over 95 percent of Florida's oranges were processed and about 95 percent of the U.S. OJ production was accounted for by Florida.

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

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 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 percent of the regular prices

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(a regular price is the median of all prices within 5 percent 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 OJ (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). Lee (2007) found that OJ 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 OJ; and whether retail promotions are more effective in selling OJ 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 Florida Department of Citrus (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 OJ, in order to ultimately increase OJ demand and improve Florida orange growers' revenue and profitability. The development of an understanding of the relationships among retail promotions, the incidences of flu and colds, and OJ demand is intended to help FDOC field representatives better assist retailers in promoting OJ 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

$$q_t = q_t(p_t, Inc_t, Prom_t, Flu_t) \tag{1}$$

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; $Flu_t$ is a flu/cold intensity measure; and $p_t$ and $Prom_t$ are vectors of prices and retail promotions, 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.,

$$\begin{aligned} q_t = {} & \alpha_0 + \Sigma_j\, \beta_j p_{jt} + \alpha_1 Inc_t + \Sigma_k\, \gamma_k\, Prom_{kt} \\ & + \alpha_2 Flu_t + \Sigma_k\, \pi_k\, Prom_{kt}\, Flu_t + \varepsilon_t. \end{aligned} \tag{2}$$

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 United States using equation (1); and the other estimates the OJ demand relationship in the 52 Nielsen markets in the United States using time-series and cross-section pooling techniques with the following specification,

$$\begin{aligned} q_{it} = {} & \alpha_0 + \Sigma_j\, \beta_j p_{jit} + \Sigma_k\, \gamma_k\, Prom_{kit} + \alpha_2 Flu_{it} \\ & + \Sigma_k\, \pi_k\, Prom_{kit}\, Flu_{it} + \varepsilon_{it}. \end{aligned} \tag{2$'$}$$

The subscript *i* denotes the $i^{th}$ market. In general, income, population composition, other demographic characteristics, and diet habits are expected to differ across markets in the United States and over 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 (1974), Da Silva (1975), Mundlak (1978), and Parks (1967).

Given that the OJ sales of the 52 Nielsen markets are measured at common points in time and that they are all U.S. markets, it is likely that the errors in the demand equations are correlated. Additionally, since these markets are different in size and population composition, we expect that the error terms of these markets have different variances. Past research suggests that weekly demand for OJ has a relatively strong inventory effect (Brown and Lee 1992). In addition, a study of a conditional juice demand system found that conditional expenditures and prices can be treated as exogenous (Brown, Behr, and Lee 1994). Equation (2′) was estimated by market using the ordinary least squares (OLS) method, and Durbin-Watson (DW) test statistics were calculated for each market. The DW test statistics for over half of the market equations indicate autoregressive error structures—the null hypothesis of $\rho = 0$ was rejected for 21 markets; for 16 markets the null hypothesis could not be rejected; the remaining DW statistics were in the inconclusive range. When equation (2′) was estimated by market using the AR(1) specification, the AR(1) parameters of 30 (of the 52) markets were statistically different from zero at $\alpha = 0.01$ level. Therefore, the approach proposed by Parks was used. Parks' approach assumes that the disturbance for each market follows an AR(1) process and that contemporaneous correlation exists. Market-specific persistence in consumption related to preferences as well as other factors is thus allowed through an autoregressive term. Formally, the error structure can be written as

$$
\text{(3)} \quad
\begin{aligned}
&E(\varepsilon_{it}^2) = \sigma_{ii} && \text{(heteroskedasticity)} \\
&E(\varepsilon_{it}\varepsilon_{jt}) = \sigma_{ij} && \text{(contemporaneously correlated)} \\
&\varepsilon_{it} = \rho_i\, \varepsilon_{it-1} + \upsilon_{it}, && \text{(autoregression)}
\end{aligned}
$$

where

$$
\text{(4)} \quad
\begin{aligned}
&E(\upsilon_{it}) = 0;\ E(\upsilon_{it-1}\upsilon_{jt}) = 0;\ E(\upsilon_{it}\upsilon_{jt}) = \varphi_{ij}; \\
&E(\upsilon_{it}\upsilon_{is}) = 0 \text{ for } s \neq t;\ E(\upsilon_{0t}) = 0; \\
&\text{and } E(\upsilon_{i0}\upsilon_{j0}) = \sigma_{ij} = \varphi_{ij}/(1 - \rho_i\, \rho_j).
\end{aligned}
$$

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 Incorporated (SDI) flu/cold intensity measure for the period from April 22, 2006 through August 2, 2008.

Two data sets were created for this study. For equation (2), weekly total OJ sales in grocery stores with annual sales of over $2 million in the United States were used. For equation (2′), weekly total OJ sales by the 52 Nielsen markets were used. The SDI data include statistics on flu/cold/respiratory illness incidences (symptoms include cough, fever, ear ache, nasal congestion, and sore throat) collected each week from thousands of healthcare providers across the United States. In equation (2), the sum of the flu incidences across the 135 SDI markets was used. In equation (2′), flu incidences of the 135 SDI markets were aggregated by Nielsen market according to the geographic areas covered by the 52 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 OJ, grapefruit juice (GJ), OJ blends, GJ blends, OJ drinks, OJ blend drinks, and GJ cocktail. A time-trend variable was used in the 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 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, GJ had the highest price among the juices/drinks examined, followed by the prices of GJ blends, GJ cocktail,

**Table 1. Sample Statistics –Market Level Data**

| Variable | Mean | Std Dev |
|---|---|---|
| Gallons Sold (1,000) – Market Level | 154.64 | 133.94 |
| Average Prices | | |
| OJ | 5.67 | 0.66 |
| GJ | 6.62 | 0.58 |
| OJ Blends | 5.73 | 0.52 |
| GJ Blends | 6.47 | 0.94 |
| GJ Cocktail | 5.79 | 0.69 |
| OJ Drinks | 3.55 | 0.65 |
| OJ 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<br><.0001* | 1.000 | | | |
| *Displays* | 0.886<br><.0001 | 0.777<br><.0001 | 1.000 | | |
| *Feature & Display* | 0.910<br><.0001 | 0.892<br><.0001 | 0.861<br><.0001 | 1.000 | |
| *Price Reduction* | 0.968<br><.0001 | 0.908<br><.0001 | 0.870<br><.0001 | 0.853<br><.0001 | 1.000 |
| | | | ***Market Level*** | | |
| **Flu/Cold** | 1.000 | | | | |
| **Cross-Product of Flu/Cold and** | | | | | |
| *Feature* | 0.902<br><.0001 | 1.000 | | | |
| *Displays* | 0.395<br><.0001 | 0.219<br><.0001 | 1.000 | | |
| *Feature & Display* | 0.707<br><.0001 | 0.673<br><.0001 | 0.619<br><.0001 | 1.000 | |
| *Price Reduction* | 0.911<br><.0001 | 0.743<br><.0001 | 0.479<br><.0001 | 0.649<br><.0001 | 1.000 |

*Prob > |r| under H0: ρ = 0.

OJ blends, 100 percent OJ, less than 100 percent OJ drinks, and OJ blend drinks. About 20 percent of the OJ was sold on feature ads without display; 17 percent on temporary price reductions; 5 percent on feature ads and display; and 2 percent on displays without feature ads. Reported U.S. flu/cold incidences averaged at about 300,000 per week with a relatively large standard deviation.

## Results

When estimating model (2) using 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 the flu/cold and retail promotional variables for the entire United States 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 the 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 conditional index (Belsley, Kuh, and Welsch 1980) has a value of 704.57. According to Belsley, Kuh, and Welsh (1980), 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 of these results, given that the purpose of this study is to examine if flu/cold incidences enhance retail promotions, exclusion of the cross-product terms between the flu/cold variable and promotional variables means the results cannot be used for this purpose.

The Parks method was used to estimate (2′), and results are shown in Table 4. The $R^2$ measure was calculated using the goodness-of-fit measure reported by Buse (1973). Coefficient estimates shown in Table 4 indicate that GJ and OJ drinks are substitutes of (100 percent) OJ, while OJ blends, GJ blends, and OJ blend drinks are complements of OJ. 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 reductions.

The coefficient estimate for the flu/cold variable by itself is negative; 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 incidences increased the effectiveness of retail promotional activities. Results indicate that every additional thousand flu/cold incidences

**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 Incidences) | 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 $\alpha = 0.05$ 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 Incidences) | -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 $\alpha = 0.05$ level. Dependent variable is measured in 1,000 gallons per week.

reported increase the impacts of retail promotional activities on OJ sales by 2.3, 2.7, 2.1, and 0.9 gallons, respectively, for features only, displays only, features and displays, and temporary price reductions. These results suggest that retail promotions during the peak flu/cold season have additional impacts on OJ demand. Flu/cold incidences had no direct impacts on the demand for OJ unless they were accompanied by retail promotions.

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

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

$$(\partial q/\partial Prom_k)(Prom_k/q) = (\gamma_k + \pi_k\, Flu)(Prom_k/q);$$

and

$$(\partial q/\partial Flu)(Flu/q) = (\alpha_2 + (\Sigma_k\, \pi_k\, Prom_k))(Flu/q).$$

Demand elasticity estimates calculated at sample means are presented in the last column in Table 4. 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. Features only had the highest demand elasticity, followed by those for temporary price reductions, features and displays, and displays only. The high elasticity estimates for features only and temporary price reduction are probably because the percent of gallons sold on features only, displays only, features and displays, and temporary price reductions are 19.7 percent, 2.4 percent, 4.7 percent, and 16.9 percent of the total gallons sold, respectively; therefore, a one percent change in features only or temporary price reductions is much higher than a one percent change in displays only or features and displays.

## Concluding Remarks

In this study, we examined the impacts of retail promotions and flu/cold incidences on the demand for OJ using weekly Nielsen grocery OJ sales and data on flu/cold incidences reported by SDI. The cross-section time-series pooling technique proposed by Parks was used to estimate the demand parameters. Results show that flu/cold incidences alone had no significant impacts on OJ sales; however, they increased the effectiveness of retail promotions on the demand for OJ. Since feature ads are widely used by retailers to promote the sales of OJ, Florida citrus growers should encourage retailers to use this tactic during the cold/flu seasons to promote OJ.

We also explored the lagged impacts of flu/cold and retail promotional tactics; however, the results were not encouraging. One of the possible reasons could be that retail promotional tactics are used to promote OJ sales on a weekly basis; therefore, these tactics may not have lagged demand impacts, such as stock and/or habit effects, on OJ sales. The flu or a cold usually lasts for a week to two weeks. As found in this study, the flu/cold variable alone had no significant impact on OJ sales; rather, it only worked through retail promotions. Therefore, there may be no lagged impacts on OJ sales associated with the flu or colds.

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