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## RELATIONSHIP BETWEEN THE UNEMPLOYMENT RATE AND THE DEMAND FOR ORANGE JUICE

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# Relationship between the Unemployment Rate and the Demand for Orange Juice

Since the economic crisis that hit the U.S. economy in 2008, the U.S. unemployment rate has roughly double, standing at 9.6% as of July 2010. The actual percentage of people out of work, however, may be significantly higher as the unemployment rate does not account for those that have stopped looking for a job but still desire employment. Nevertheless, the reported unemployment rate provides important information on the state of the economy and may be useful to explain some market situations. With family budgets of the unemployed becoming strained, the demands for various products may decline. The purpose of this study is to examine the relationship between the unemployment rate and the demand for one product group, orange juice (OJ).

The analysis is based on sales data provided by Nielsen for grocery stores that do $2 million or greater business annually, drug stores that do $1 million or greater business annually, and mass merchandisers (K-Mart and Target), as well as data provided by Wal-Mart. Data for four census regions (Northeast, Midwest, South, and West) and the entire United States were examined. The period from week ending 3/1/08 through 5/1/10, 114 weeks (about 2.2 years), was studied. The raw Wal-Mart data included dollar sales and unit sales; units were transformed to single-strength-equivalent (SSE) gallons using the factor .57 SSE gallons per unit based on Nielsen panel data. Gallons and dollar sales were aggregated across outlets and the price of OJ was measured by average revenue---dollar sales divided by gallons sales.

## Model

The log of OJ gallon sales was specified as a function of 1) the log of its own price deflated by the consumer price index for food and beverages (Bureau of Labor Statistics), 2) the level of own promotion measured by the share of dollar sales on promotion (features, displays, both features and display, and temporary price discounts)[1], 3) the log of a variable measuring awareness of the flu (Google flu),[2] 4) the unemployment rate (Bureau of Labor Statistics), and two seasonality variables, sine and cosine (Brown). The unemployment rate reflects, in part, income effects---income was not included in the model to reduce multicollinearity.

The demand relationship at the U.S. level was initially estimated by ordinary least squares (OLS). First-order autocorrelation, however, was present and the model was re-estimated correcting for this problem.

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[1] Promotion dollar sales were for Nielsen outlets (data on Wal-Mart promotions were not provided).
[2] http://www.google.org/flutrends/us/data.txt

The fixed effects, cross-section, time-series model was used to analyze the regional data. It was assumed that the model's intercept, and sine and cosines coefficients vary by regions, but the coefficients on the other variables were the same across the regions. The sine and cosine variables reflect time effects---dummy variables for the weeks studied were omitted to reduce multicollinearity problems. Formally, the demand for OJ by city, by week can be written as

$$(1)\ \log q_{it} = \mu_i + \beta_1 \log p_{it} + \beta_2 promo_{it} + \beta_3 \log flu_{it} + \beta_4 unem_{it} + \beta_{i5} sine_{it} + \beta_{i6} cosine_{it} + \varepsilon_{it}$$

where subscripts i and t stand for the region and week, respectively; q is OJ gallons; p is OJ price; promo is the share of dollars on promotion; flu is the Google measure of the flu; unem is the unemployment rate; and $\varepsilon_{it}$ is an error term. The coefficients $\beta_1$ and $\beta_3$ are the own price and flu elasticities, respectively, indicating percentage changes in demand for one percent changes in the price and level of flu awareness; while $\beta_{2,}$ $\beta_4$, $\beta_{i5}$, and $\beta_{i6}$ indicate percentage changes in demand for unit changes in the associated variables. The coefficient $\mu_i$ indicates a region specific effect (measured by dummy variables). Regions have different populations and perhaps preferences based on the demographic background of its population, all of which likely influence $\mu_i$. Since the time period analyzed is relatively short, population and preferences are treated as constant for a region, and it is assumed that the coefficient $\mu_i$ is constant over the weeks studied. Generic and brand OJ advertising, and changes in competitive product prices and advertising levels were not explicitly included in the model, but to the extent these factors follow a seasonal patter over the time period studied, their effects are reflected by the sine and cosine variables.

Model (1) was estimated using the Parks method which allows the error terms to be contemporaneously correlated across regions, and follow region-specific first-order autocorrelation processes--- $E(\varepsilon^2_{it}) = \sigma_{ii}$ (heteroscedasticity), $E(\varepsilon_{it}\ \varepsilon_{jt}) = \sigma_{ij}$ (contemporaneous correlation), and $\varepsilon_{it} = \rho_i \varepsilon_{it-1} + \nu_{it}$ (autocorrelation).

A model based on disaggregated data for 52 cities and the remaining U.S. was also estimated. The model for these data can be written as

$$(2)\ \log q_{it} = \mu_i + \beta_1 \log p_{it} + \beta_2 \log ps_{it} + \beta_3 promo_{it} + \beta_4 \log flu_{it} + \beta_5 unem_{it} + \beta_{i6} sine_{it} + \beta_{i7} cosine_{it} + \varepsilon_{it}$$

where subscript i now stands for a city or the rest of the U.S.; p is the un-deflated OJ price, as opposed to the deflated price in equation (1); and ps is the price for OJ drinks, OJ blends, OJ blend drinks, grapefruit juice (GJ), GJ cocktail, and GJ blends. The city by city data provide increased variation in the unemployment rate. Consistent data on the consumer price index for foods and beverages were not available; and the alternative price ps was included instead.

## Model Estimates

Table 1 shows the model estimates based on the aggregate U.S. data. Two set of estimates are provided---estimates based on the OLS and the first-order autocorrelation methods.

All coefficient estimates for both methods had the correct sign and were statistically significant, at $\alpha = 10\%$ level or lower, except that for the promotion variable based on the OLS method. The own price elasticity estimates was negative, OJ promotions and the flu had positive effects; the sine and cosine coefficients indicated seasonality; and the coefficient on the unemployment rate was negative. The OLS and autocorrelation-corrected unemployment coefficients were -.021 and -.28, respectively, and given the unemployment rate has increased about 4.5 points over the sample period (average over first 26 weeks versus average over last 26 weeks), the impact on OJ gallon sales is 9.5% to 12.6%.

Table 2 shows the estimates based on the regional data (intercept and regional dummy coefficient estimates are excluded). These results are consistent with those in Table 1. The unemployment coefficient estimates based on the regional data were -.025 (OLS) and -.034 (Parks). The later estimate suggests a somewhat larger impact of unemployment on OJ sales than found based on the aggregate U.S. data.

Results for the city model are shown in Table 3. Estimates of the coefficients for the numerous city dummy, sine and cosine variables are omitted to focus on the other variable impacts. In general, the city model results are consistent with those for the U.S and regional models. The unemployment coefficient estimates are -.017 (OLS) and -.024 (Parks). These estimates are somewhat smaller (in absolute value) than those for the other two models, suggesting a 4.5 point change in the unemployment rate results in a 7.7% to 10.8% change in OJ demand.

It is possible that the unemployment rate in these models is capturing the impacts of more than just unemployment. The unemployment rate roughly follows an upward trend over the sample, and it may also be reflecting the impacts of other correlated factors. One possible factor may be preferences for reduced calories in foods and drinks. Given lack of good data on such other factors, it is difficult to determine extent of this problem or whether there is a problem at all, and even with more data, multicollinearity might preclude more precise estimation.

## Conclusions

This study examined the relationship between the unemployment rate and the demand for OJ. Based on the demand estimates obtained, the hypothesis that unemployment is having a significant negative impact on OJ demand cannot be refuted. Over the sample period, the unemployment rate increased by about 4.5 points, resulting in a 7.7% to 12.6% decline in OJ demand, based on the alternative model estimates. The unemployment rate, however, has trended upward in recent years, raising the possible that it may be reflecting to some extent the impact of other trend related factors such as preferences for reduced calories.

## References

Brown, M. "Impact of Income on Price and Income Responses in the Differential Demand System," *Journal of Agricultural and Applied Economics*. 40, 2 (August), 2008: 593-608.

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. OLS and First-Order Autocorrelation Estimates of OJ Demand, Based on Total U.S. Data.

| | OLS | | | First Order Autocorrelation | | |
|---|---|---|---|---|---|---|
| Variable | Coeff. Est. | t Value | Pr > \|t\| | Coeff. Est. | t Value | Pr > \|t\| |
| Intercept | -2.930 | -8.460 | <.0001 | -2.680 | -6.840 | <.0001 |
| Log own price | -0.692 | -2.560 | 0.012 | -0.959 | -3.160 | 0.002 |
| Promotion | 0.227 | 1.460 | 0.146 | 0.416 | 2.460 | 0.016 |
| Log flu | 0.026 | 2.880 | 0.005 | 0.024 | 1.970 | 0.052 |
| Unemployment | -0.021 | -2.940 | 0.004 | -0.028 | -3.510 | 0.001 |
| Sine | 0.038 | 5.750 | <.0001 | 0.039 | 4.250 | <.0001 |
| Cosine | -0.048 | -8.470 | <.0001 | -0.049 | -6.280 | <.0001 |
| Lagged Error | | | | 0.362 | 4.000 | <.0001 |
| DW | 1.232 | | | 1.882 | | |
| R2 | 0.685 | | | 0.735 | | |

Table 2. Fixed Effects, Time Series, Cross-Section Estimates of OJ Demand, Based on Regional U.S. Data.

| | OLS | | | Parks Method | | |
|---|---|---|---|---|---|---|
| Variable | Estimate | Value P | r > \|t\| | Estimate | Value | Pr > \|t\| |
| Log own price | -1.003 | -11.080 | <.0001 | -1.374 | -17.030 | <.0001 |
| Promotion | 0.238 | 3.550 | 0.000 | 0.206 | 3.780 | 0.000 |
| Log flu | 0.018 | 4.300 | <.0001 | 0.043 | 3.670 | 0.000 |
| Unemployment | -0.025 | -9.660 | <.0001 | -0.034 | -7.240 | <.0001 |
| Sine City 1 | 0.029 | 4.720 | <.0001 | 0.022 | 1.030 | 0.304 |
| Sine City 2 | 0.035 | 5.750 | <.0001 | 0.000 | -0.010 | 0.996 |
| Sine City 3 | 0.048 | 7.940 | <.0001 | 0.041 | 2.330 | 0.020 |
| Sine City 4 | 0.045 | 7.140 | <.0001 | 0.046 | 1.420 | 0.156 |
| Cosine City 1 | -0.050 | -8.810 | <.0001 | -0.050 | -2.550 | 0.011 |
| Cosine City 2 | -0.049 | -8.630 | <.0001 | -0.103 | -2.480 | 0.013 |
| Cosine City 3 | -0.035 | -5.900 | <.0001 | -0.030 | -1.750 | 0.081 |
| Cosine City 4 | -0.066 | -11.380 | <.0001 | -0.062 | -2.020 | 0.045 |
| R2* | 0.950 | | | 0.518 | | |

*R2 for Parks Method is based on measure suggested by Buse (1973).

Table 3. Fixed Effects, Time Series, Cross-Section Estimates of OJ Demand, Based on City Data.

| | OLS | | | Parks Method | | |
|---|---|---|---|---|---|---|
| Variable | Estimate | Value P | r > \|t\| | Estimate | Value | Pr > \|t\| |
| Log own price | -1.102 | -62.980 | <.0001 | -1.126 | -15.520 | <.0001 |
| log subst. price | -0.005 | -0.430 | 0.666 | 0.002 | 0.060 | 0.954 |
| Promotion | 0.169 | 12.050 | <.0001 | 0.309 | 5.640 | <.0001 |
| Log flu | 0.011 | 7.400 | <.0001 | 0.011 | 0.780 | 0.436 |
| Unemployment | -0.017 | -33.410 | <.0001 | -0.024 | -2.860 | 0.004 |
| R2* | 0.950 | | | 0.830 | | |

*R2 for Parks Method is based on measure suggested by Buse (1973).