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THE IMPACT OF GENERIC ORANGE JUICE ADVERTISING

BY

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The Impact of Generic-Orange Juice Advertising1

In this study, the impacts of Florida Department of Citrus (FDOC) orange juice (OJ) advertising on U.S., OJ demand and the price received by Florida growers are examined. FDOC advertising is generic focusing on common attributes of OJ products such as vitamin C and other health factors. The advertising is intended to increase U.S. volume sales and ultimately Florida grower prices. Since OJ is a globally traded commodity, the U.S. market is analyzed in context to the rest of the world (ROW).

The data examined include U.S. OJ gallon sales in million of single strength equivalent (SSE) gallons reported by FDOC; the (delivered-in) Florida grower price in dollars per SSE gallon reported by the United States Department of Agriculture, National Agricultural Statistic Service (USDA-NASS); the consumer price index (CPI) reported by the U.S. Bureau of Labor; generic OJ advertising in million of dollars (FDOC), and world OJ supply in millions of SSE gallons. World supply in the present analysis is comprised of U.S. and Brazil production and inventories plus a relatively minor amount of production from foreign suppliers sold in the U.S. The U.S. and Brazil account for about 85% of the production of OJ in the world. Annual data from the 1980-81 season (October-September) through the 2006-07 season were examined. Descriptive statistics of basic variables are provided in Table 1.

Model

The model is comprised of two interrelated equations. The first equation relates U.S. gallon sales of OJ to price and the level of advertising, while the second equation relates the price to the world supply and the advertising impact of the first equation. The first equation indicates how U.S. gallons sales change in response to a change in advertising. The second equation indicates how the change in gallon sales due to advertising, determined from the first equation, impacts price. Basic market driving forces are maintained in the model, but various assumptions are made to analyze the data available. The aggregate amount of OJ in various products is treated as a single good in a world market. The world market is divided into the U.S. market and ROW. The impact of only generic (FDOC) OJ advertising occurring in the U.S. market is examined.[2] FDOC advertising results in excess demand in the U.S. market at the pre-advertising price level. With the advertising focused on the U.S. market, no excess demand occurs in the ROW at this price. Given the quantity demanded in the world market is the sum of the demand levels in the U.S. and ROW markets, the excess demand in the world market equals the excess demand in the U.S. market. The excess demand then results in an increase in the world price. Conversely, elimination of advertising causes excess supply resulting in a lower price.

There are various prices for OJ in the world, depending on product, location and the level in

1 By Mark Brown.

2 In recent past studies, aggregate brand advertising across OJ products has not been found to have a significant impact on overall OJ category sales (e.g., Brown and Lee, FABA), although advertising for a specific OJ brand has been found to significantly enhance that brand's demand (Brown and Lee).

the marketing chain. These prices tend to be highly correlated,[3] and it is assumed that world OJ supply and demand responses to prices can be approximated using a single price. Using one price simplifies the analysis and avoids multicollinearity problems associated with using multiple prices. The question is which OJ price to use in our model. Given the focus of this study on the impact of advertising on the Florida grower price, the latter grower price was chosen.[4]

The use of a single OJ price in modeling interactions across world OJ markets follows a study by McClain where the FOB Santos (Brazil) price was used as a base price and prices across markets differed from this base by transportation and tariff charges. Tariffs have changed little over the time period studied, and what changes occurred have been phased-in, following a trend. Likewise, changes in transportation costs have been largely related to the trend in increased energy costs. In the present study, these charges are absorbed in the intercept and trend variables of the model.

Formally, the demand for OJ in the U.S. can be written as

(1) $$q_1 = \beta_{10} + \beta_{11}\, t + \beta_{12}\, p + \beta_{13}A + \varepsilon_1,$$

where q_1 is the quantity demanded (million gallons), t is a time trend, p is the price ($/SSE gallon), A is advertising (dollars), and ε_1 is an error term. Price p and advertising a are deflated by the consumer price index (CPI). The β's are coefficients to be estimated.

The trend variable reflects the aggregate impact of changes in preferences over time and growth in the U.S. population, U.S. disposable income, and competitive beverage gallon sales, all of which were highly correlated with t over the time period studied. Given that some of these factors, such as population and income, may positively impact OJ demand, while others, such as diet trends and growth in competitive beverage sales, may negatively impact demand, it is not clear what the sign on the trend-variable coefficient (β_{11}) should be.

Although not explicitly examined, consider the demand for OJ in ROW. Formally, ROW

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3 The correlation coefficients between the Florida grower price and the futures price for frozen concentrated orange juice (FCOJ), the Florida grower price and the Florida FOB price for bulk FCOJ, and the Florida grower price and the Brazil, Santos FOB price for FCOJ are .95, .97 and .90, respectively. Differences in the correlations may be due in part to the time periods underlying the calculations. The grower-futures correlation is based on annual data over the period from 1980-81 through 2006-07 (October through September); the grower-Florida FOB correlation is based on annual data over the period from 1988-89 through 2006-07 (October through September), and the grower-Santos FOB correlation is based on annual Santos price data over the period from 1974 through 1997 (January through December) and 1997-98 through 2006-07 (July through June) versus Florida grower price data on a October through September season. The lower correlation between the Florida grower price and the Santos price may be partly due to the less closely matched data, by time period, used in the calculation.

4 Since advertising directly impacts consumer demand, ideally, the price in our model would be the retail price. Consistent data on the retail price, however, were not available for the time period studied. However, if such data were available and the model were specified in terms of the retail price, examination of the impact of advertising on the grower price would require an additional equation relating the retail price to the grower price. An advantage of directly specifying the model in terms of the grower price is that such a retail-grower price equation is not needed.

demand can be written as

(2) $$q_2 = \beta_{20} + \beta_{21} t + \beta_{22} p + \varepsilon_2,$$

where q_2 is the quantity demanded (million gallons) and ε_2 is another error term. Equation (2) is not estimated but it underlies the analysis. In the demand equation for ROW, the advertising variable (A), specific to the United States, is omitted, since most ROW consumers are not exposed to U.S. advertising. Similar to the motivation of including t in U.S. demand equation, ROW population, income and time are relatively highly correlated, and the variable t is included in equation (2)as an approximation. The rational for using the deflated price variable p in the ROW demand equation is the same as in the U.S. demand equation---the CPI in the denominator of this variable reflects the price of other U.S. goods available in the market. Exchange rates are not explicitly considered given the large number of countries in the ROW and exchange rates involved. The ROW demand equation is also assumed to reflect demand for (ending) OJ inventories.

Letting Q be the total supply, the world supply and demand equilibrium ($Q = q_1 + q_2$) can be written as

(3) $$Q = (\beta_{10} + \beta_{20}) + (\beta_{11} + \beta_{21})t + (\beta_{12} + \beta_{22}) p + \beta_{13}A + (\varepsilon_1 + \varepsilon_2).$$

The supply Q is assumed to be exogenous, comprised of world production plus beginning inventories. The price p is endogenous, and, thus, inverting equation (3), the world inverse demand equation is

(4a) $$p = ((Q - (\beta_{10} + \beta_{20}) - (\beta_{11} + \beta_{21})t - \beta_{13} A - (\varepsilon_1 + \varepsilon_2))/(\beta_{12} + \beta_{22}),$$

or

(4b) $$p = \gamma_0 + \gamma_1 Q + \gamma_2 t - \gamma_1 \beta_{13}A + \varepsilon,$$

where $\gamma_0 = - \gamma_1 (\beta_{10} + \beta_{20})$, $\gamma_1 = 1/(\beta_{12} + \beta_{22})$, $\gamma_2 = - \gamma_1 (\beta_{11} + \beta_{21})$, and $\varepsilon = -\gamma_1 (\varepsilon_1 + \varepsilon_2)$.

The error- covariance matrix for equations (1), (2) and (4b) is singular (multiplying ε_1 and ε_2 by γ_1 and adding the results to ε equals zero). Dropping one of the demand equations eliminates this problem. In our analysis, equations (1) and (4b) are jointly estimated using the full information maximum likelihood procedure (TSP). The estimation procedure incorporates the information on the correlation between the error terms ε_1 and ε, and corrects for the endogeneity problem in equation (1) where price is an explanatory variable.

Note that the advertising impact $\beta_{13}A$ appears in both equations (1) and (4b). This term represents the gallons sold due to advertising, price constant. If advertising were eliminated the amount $\beta_{13}A$ (excess supply) would have to be moved by lowering price. The coefficient γ_1 in equation (4b) translates this gallon shortfall into a price impact. Thus, the impact of advertising on the grower price is $- \gamma_1\beta_{13}A$. The impact is expected to be positive, given the coefficients γ_1 and β_{13}

are expected to be negative and positive, respectively. The elimination of advertising is equivalent to an increase in supply of $\beta_{13}A$.

Estimating equation (1) and (4b) jointly takes advantage of the interrelationship between the quantity-advertising relationship and price-quantity relationship. A degree of freedom is saved by specifying the effect of advertising through the two coefficients γ_1 and β_{13} in equation (4b), as opposed to an additional joint coefficient, say $\gamma_3 = \gamma_1\beta_{13}$. The multiplicative specification involving the advertising and price coefficients ($\gamma_1\beta_{13}$) means that variations in advertising, along with variations in supply, help identify the inverse demand price coefficient (γ_1), similar to the use of the Tintner-Ichimura specification in estimating the Slutsky coefficients in the Rotterdam model.

Results

In preliminary analysis, current and one-year lagged levels of advertising were found to significantly impact U.S. demand for OJ and the grower price, equations (1) and (4b), respectively. Additionally, a first degree (linear) Almon polynomial lag structure was imposed with the second lag coefficient restricted to be zero, based on the likelihood ratio test. Attaching subscript t to the advertising variable in equations (1) and (4b), the term $\beta_{13}A_t$ becomes $\beta_{130}A_t + \beta_{131}A_{t-1}$ or $\beta_{130}(A_t + .5A_{t-1})$, imposing the zero-end-point restriction on the second lag coefficient ($\beta_{132} = 0$ on A_{t-2}). Thus, the advertising variable A_t is replaced by ($A_t + .5A_{t-1}$) in the model equations.

Estimates of U.S. OJ demand equation (1) and grower price equation (4b) are shown in Table 2. Two sets of estimates are shown---the first set (unrestricted model) includes the time trend variable t, while the second set (restricted model) excludes this variable. In the unrestricted model, the trend coefficients were not significantly different from zero at the $\alpha = .10$ level or any reasonable level of significance. Further, based on the likelihood ration test, the restricted model can not be rejected at any reasonable level (the difference in the log likelihood value between the restricted an unrestricted models is relatively small (footnotes a and b of Table 2); twice this difference is asymptotically distributed as a chi-square statistic with the degrees of freedom equal to the number of restrictions, two in the present case). It thus appears that the various factors underlying the trend coefficient estimates (those factors that are highly correlated with t) are having offsetting effects; for example, possible positive effects related to such factors as growth in population and income are apparently being offset by possible negative effects due to such other factors as growth in competitive beverage consumption and diet trends.

In the U.S. OJ demand equation (1), the coefficient on price was statistically significant and had a negative sign, reflecting the law of demand (the inverse relationship between quantity demanded and price). In the grower price equation (4b), the coefficient on the quantity of OJ available in the world was also significant and negative, following the law of demand. The estimate of the advertising coefficient, shared by equations (1) and (4b), was significant and positive, indicating that FDOC generic advertising enhanced U.S. OJ demand, and, along with the coefficient on supply, the grower price.

The model was used to determine the mean impact of advertising over the sample period (Table 3). The impact of advertising on gallon sales was estimated as $\beta_{14}(A_t + .5A_{t-1})$ (price constant), while the impact of advertising on price was estimated as $-\gamma_1\beta_{14}(A_t + .5A_{t-1})$, with the term $A_t + .5A_{t-1}$ set at its sample mean value The mean impact of advertising on U.S. OJ demand with price constant was found to be 482 million SSE gallons, while the mean impact on the grower price was \$.33 per SSE gallon. The increase in price, in turn, results in a decrease in the quantity demanded in the U.S. market of 106 million SSE gallons (β_{12} dp, where dp = .33), and the overall impact of advertising on U.S. demand was 376 million SSE gallons (482 million gallons due to advertising alone minus106 million gallons due to price).

The findings of this study are relatively similar to those found by FABA (2003) and a panel of economists led by Ron Ward (2005). The FABA study found that the long-run elasticity for U.S. OJ demand was .428 $(\partial q/\partial A)(A/q)$),and, given the FABA demand equation was linear, multiplying this elasticity times the present study's mean U.S. consumption of 1309.9 million SSE gallons implies an average advertising impact of 560 million SSE gallons (price constant), compared to the 482 million SSE gallons noted above. When all the other effects, including the higher price induced by advertising, were considered, FABA estimated advertising increased U.S. OJ consumption by 388 million SSE gallons, compared to the 376 million gallons estimated above.

An important factor underlying the advertising impact is the price-quantity slope in the world market. In the Ward et al study, this slope was estimated at -.0006 to -.0007 dollars per million SSE gallons, versus the -.0007 value in the present study (rounded to -.001 in Table 2). This slope is multiplied by the volume advertising impact in the U.S. market to find the impact of advertising on price (as done above). Hence, for each 100 million SSE gallon increase in U.S. sales due to advertising (price constant), the grower price increases by 6 cents or 7 cents based on the Ward et al findings and 7 cents based on the present findings.

The above estimates of this study are based on deflating the price of OJ by the CPI in equations (1) and (4b). An alternative specification of the model would be to leave the price un-deflated (the nominal price) and include time as explanatory variable in both equations. The deflated and un-deflated models are not nested, and some nonnested testing procedure is required to choose between the models. In this study, the alternative specifications of equations (1) and (4b) were tested individually and jointly by specifying a general model that includes both the deflated and un-deflated hypotheses (Maddala). The general model for equation (1) adds the nominal price and time to the restricted specification of the deflated model. Appropriate restrictions on the parameters of the general model yield the deflated and un-deflated specifications. Since price is endogenous, the two stage least squares method was used to estimate the model (the instrumental variables used were time, the advertising variable, total supply, the CPI and a constant). The t and Wald tests were used to test the restrictions. The results were inclusive---both models were acceptable. A similar test was conducted on equation (4b). To conduct this test, the deflated specification of this equation (the restricted version without time as an explanatory variable) was re-specified by multiplying both sides of the equation by the CPI, leaving the price un-deflated or in its nominal form. The explanatory variables of this specification are the CPI, the CPI times supply and the CPI times the advertising variable (there is no intercept now). The general model combines the latter specification with the un-deflated model that relates the nominal price to supply, time and the advertising variable. The tests on the parameter restrictions underlying the alternative specifications were again inconclusive with respect to model choice (the Davidson and MacKinnon nonnested test or J test was also conducted, yielding inconclusive results). Lastly, the two general specifications of equations (1) and (4b) were combined and estimated by the full information maximum likelihood procedure, and the parameter restrictions for the deflated and un-deflated models were tested using the Wald and likelihood ratio tests. Again the tests were inconclusive. Thus, the un-deflated model deserves consideration.

Estimates of the un-deflated model are shown in Table 4. All coefficient estimates were significant and had expected signs. The important price-quantity slope was -.00056, compared to the -.0007 slope for the deflated model mentioned above. (The deflated model slope was actually -.00069.) Table 5 shows the impacts of advertising for the un-deflated model based on the sample mean advertising level. For this specification, the grower price is increased by 26 cents per SSE gallons as opposed to 33 cents per gallon for the deflated model.

Conclusions

The findings of this study can be used as a basis for estimating the impact of advertising on the grower price using more current information on the impact of advertising on gallon sales. The FDOC has hired Marketing Accountability Partnership (MAP) to provide an independent estimate of the impact of FDOC advertising on U.S. OJ volume sales. This estimate can be multiplied by an estimate of the price-quantity slope of equation (4b) to obtain an estimate of the impact of advertising on the grower price. Given two defendable estimates of the price-quantity sloped are available (those based on the deflated and un-deflated models), the average of these two might be used. This average is -.000625 per million SSE gallons. In this case, a 100 million gallon increase in OJ sales due to advertising results in a 6.25 cent increase in the grower price. After estimating the impact of advertising on price, grower benefits can be estimated by apply the price increase to grower production and comparisons to the costs of advertising can be made.

Table 1. Descriptive Statistics of OJ Demand Variables.

Variable	Unit	Mean	Std Dev
U.S. Demand (q1)	mil. SSE ga.	1309.90	164.41
Grower Price (p)	$/SSE ga.[a]	1.08	0.27
Advertising (A)[a]	mil. $[a]	39.23	7.42
World Supply (mil. SSE ga.)	mil. SSE ga.	3118.01	874.80

[a] Deflated by the CPI; in 2007 prices.

Table 2. Full Information Maximum Likelihood Estimates of U.S. OJ Demand Equation (1) and Price Equation (4b), Deflated Price.

	Equation/Parameter	Estimate	Std Error	t-statistic	P-value
Unrestricted Model[a]					
U.S. OJ Demand	Intercept (β10)	1285.580	297.989	4.314	[.000]
	Time (β12)	2.861	7.052	0.406	[.685]
	Price (β13)	-280.340	76.997	-3.641	[.000]
	Advertising (β14)	7.339	3.013	2.436	[.015]
Grower Price	Intercept (γ0)	3.646	0.237	15.388	[.000]
	Supply (γ1)	-0.001	0.000	-7.034	[.000]
	Time (γ1)	0.013	0.016	0.845	[.398]

[a] R-squares for the U.S. OJ demand and grower price equations were .70 and .88, respectively; log likelihood value=-144.447.

	Equation/Parameter	Estimate	Std Error	t-statistic	P-value
Restricted Model[b]					
U.S. OJ Demand	Intercept (β10)	1369.510	137.996	9.924	[.000]
	Time (β12)				
	Price (β13)	-316.122	51.439	-6.146	[.000]
	Advertising (β14)	7.614	2.910	2.616	[.009]
Grower Price	Intercept (γ0)	3.540	0.233	15.219	[.000]
	Supply (γ1)	-0.001	0.000	-11.561	[.000]
	Time (γ2)				

[b] R-squares for the U.S. OJ demand and grower price equations were .67 and .88, respectively; log likelihood value=-144.967.

Table 3. Impacts of Advertising, Deflated Price Model, Based on the Mean Advertising Level.

	Unit	Mean	Std Dev
On U.S. OJ Sales, Price Constant	mil. $[a]	482.02	90.32
On Grower Price	$/SSE ga.[a]	0.33	0.06
On U.S. OJ Sales, Price Changes	mil. $[a]	376.42	70.53

Table 4. Full Information Maximum Likelihood Estimates of U.S. OJ Demand Equation (1) and Price Equation (4b), Un-deflated Price.[a]

	Equation/Parameter	Estimate	Std Error	t-statistic	P-value
U.S. OJ Demand	Intercept (β10)	1046.500	245.640	4.260	[.000]
	Time (β12)	18.115	4.154	4.361	[.000]
	Price (β13)	-398.362	106.119	-3.754	[.000]
	Advertising (β14)	7.167	2.985	2.401	[.016]
World Price	Intercept (γ0)	1.939	0.175	11.067	[.000]
	Supply (γ1)	-0.001	0.000	-7.731	[.000]
	Time (γ2)	0.048	0.009	5.246	[.000]

[a] R-squares for the U.S. OJ demand and grower price equations were .72 and .68, respectively; log likelihood value=-134.217.

Table 5. Impacts of Advertising, Deflated Price Model, Based on the Mean Advertising Level.

	Unit	Mean	Std Dev
On U.S. OJ Sales, Price Constant	mil. $[a]	453.71	85.02
On Grower Price	$/SSE ga.[a]	0.26	0.05
On U.S. OJ Sales, Price Changes	mil. $[a]	352.08	65.97