RESEARCH PAPER: 2002-1

ADVERTISING IMPACTS ON DEMAND FOR ORANGE JUICE – JANUARY 2002

BY

Mark G. Brown

Senior Research Economist

FLORIDA DEPARTMENT OF CITRUS

Economic and Market Research Department

P.O. Box 110249

Gainesville, Florida 32611-2049 USA

Phone: 352-392-1874

Fax: 352-392-8634

Email: mgbrown@ufl.edu

www.floridajuice.com

Advertising Impacts on Demand for Orange Juice
January 2002

Abstract

Both a single equation model and Rotterdam demand system were used to estimate the impact of advertising on OJ demand. In the single equation model, orange juice (OJ) gallon sales were related to OJ advertising, grapefruit juice (GJ) advertising, the price of OJ, seasonality variables, consumer income, and a dummy variable for September 11 to further capture possible effects resulting from changes in the U.S. economy and consumer confidence after that point in time. The impact of each of these variables was estimated by applying the ordinary least squares regression method to data from September 1997 to November 2001. The results suggest that recent decreases in OJ demand are related to declines in FDOC advertising, as well as perhaps declines in income and changes in consumer behavior since September 11. Prices have been relatively flat in the past year and appear to have had little impact on OJ demand. Overall, declines in FDOC advertising were estimated to have resulted in a 4% to 5% decline in OJ demand. The Rotterdam model estimates were relatively similar.

Introduction

The U.S. market for OJ is subject to two basic types of advertisements—generic advertising and brand advertising. Generic advertising is intended to increase the demand for the overall OJ category, while brand advertising is intended to increase the demand for the OJ brand in question. Generic advertising is carried out by the Florida Department of Citrus (FDOC), while brand advertising is carried out by different companies. Brand advertising may result in shifting market shares of individual companies with little or no change in overall OJ sales (increases in demand for advertised brands may be offset by decreases in the demand of non-advertised brands). However, brand advertising may also have a generic impact. Demand increases for advertised brands may more than offset possible demand decreases for non-advertised brands or perhaps a company's brand advertising may have an unintentional spillover effect enhancing the demand for not only the brand in question but also the demand for competitive OJ products. The end result of brand advertising could be an increase in overall OJ sales.

This study examines the impacts of FDOC generic OJ advertising, brand OJ advertising and total (FDOC generic and brand) GJ advertising on OJ gallons sales in ACNielsen retail outlets. The advertising variables are measured by gross rating points (GRPs) for TV advertising. Two modeling approaches were used to examine the impacts of GRPs. The first approach is based on a single demand equation that relates retail OJ gallon sales to generic and brand OJ advertising, GJ advertising, the price of OJ, consumer income, inflation, population, and a dummy variable for September 11. The OJ brand advertising in this model is the aggregate advertising by the three major OJ brands—Tropicana, Minute Maid and Florida's Natural; while the GJ brand advertising is the aggregate advertising by the three major GJ brands—Tropicana, Ocean Spray and Florida's

Natural. The second approach is based on a demand system which examines separate advertising effects for individual brands, as well as for the FDOC.

The equations were estimated using ACNielsen data for grocery store chains doing at least $2 million annual business plus super centers, and advertising GRPs provided by the Richards Group. The ACNielsen data are on a weekly basis and include dollar and gallon sales for various OJ and GJ categories (prices were derived by dividing dollar sales by gallon sales). U.S. Department of Commerce data on the U.S. population, U.S. disposable income, and the consumer price index (CPI) were also used in constructing some of the variables analyzed (gallon sales were transformed to per capita levels; prices were deflated by the CPI in the single equation model; and disposable income was transformed to per capita income and deflated by the CPI) . The GRP data are quarterly and were combined with the weekly ACNielsen data by repeating the quarterly GRP levels for each week in a given a quarter. The period from week ending 9/13/97 to 11/24/01 was studied (220 weekly observations).

GRPs and Media Advertising

GRPs and media OJ advertising expenditures (Competitive Media Reporting or CMR) for the three major brands and the FDOC are shown in Table 1. The GRPs are a measure of TV advertising while media advertising includes TV, radio and print advertising. From 1997 through 2000, the FDOC share of total GRPs (media expenditures) for the major brands plus FDOC ranged from 24 % to 35% (19% to 24%). In 2001, the FDOC share of GRPs (media expenditures) decreased to 20% (11%).

OJ advertising decreased notably in 2001, with FDOC and major-brand GRP levels being down 55% and 3%, from the previous year's levels, respectively, while FDOC and major-brand media expenditures were down 63% and 20%, respectively.

Over the period studied, the cost of advertising (media inflation) increased significantly so that media expenditure may not reflect actual advertising effort. Media expenditures deflated by a cost index or GRPs are alternatives for measuring advertising effort. In this study, GRPs were used because the inflation rate for OJ advertising was not available. (A rough measure of general inflation for media advertising was available and used in a preliminary analysis to deflate OJ media advertising expenditures and in turn determine the impact of advertising on OJ demand; the results for this analysis were similar to those based on the use of GRPs.)

Graphically, a relationship between FDOC GRPs and OJ volume sales appears to exist (Figures 1, 2 and 3). Figure 1 shows that FDOC GRPs follow weekly OJ volume sales relatively closely. However, OJ sales follow a seasonal pattern (high in the winter and low in the summer). Does seasonality exist independently of advertising, or does advertising contribute to the pattern? It is difficult to determine from Figure 1. One way to remove the seasonal pattern is to plot the 52 week moving averages (for the 52 weeks in a year) for these two variables (Figure 2). Based on this seasonality adjustment, a positive relationship between OJ volume sales and FDOC GRPs seems to exist (the sharper turns in the GRP average is related to repeating the quarterly GRP levels for each week in a given a quarter). In subsequent analysis, a stock of FDOC GRPs is estimated, and the plot of the 52 week average for this stock against OJ volume sales is shown in Figure 3, further supporting a relationship. Nevertheless, other factors may actually be driving OJ sales, and the following analysis attempts to determine the separate impacts of advertising and some other important demand factors.

Merchandising Versus GRPs

Caution should be taken in interpreting the results of this study as the GRP measure of advertising was likely collinear with other merchandising/promotion effort over the sample, and our estimated GRP impacts may reflect joint TV-merchandising-promotion efforts. FDOC TV advertising had been supported by various merchandising and promotion efforts by the FDOC field staff until the spring of 2001, including various store promotions, newspaper ads, and coupons. In an attempt to capture the effects of FDOC and other manufacturers merchandising activities, measures of in- store promotion provided by ACNielsen were included in the regression analysis. However, these ACNielsen variables are rough measures and may not reflect actual merchandising efforts.

With FDOC merchandising tending to go hand-in-hand with TV advertising, including sharp declines in both activities in 2001, and given the consequent possibility that the subsequent, reported FDOC GRP impact estimates are capturing not only the impact of TV advertising but the impacts of FDOC merchandising, it should be recognized that a resumption of TV advertising without merchandising support may have a smaller impact than predicted by our analysis.

Modeling Approaches

A single equation for overall OJ demand and a demand system model for individual brands were considered. The single equation model focuses directly on possible generic advertising impacts stemming from FDOC and aggregate-brand GRPs. The system of demand equations focuses on individual brand demands, explicitly allowing for brand shifting as well as FDOC/aggregate-brand generic impacts. The differential demand system or Rotterdam model (Theil 1971, 1975, 1976, 1980a,b) is used in specifying this model.

Single Equation Model

Formally, the single equation model can be written as

$$(1)\quad q_t = \alpha_0 + \alpha_1{*}p_{1t} + \alpha_2{*}p_{2t} + \alpha_3{*}inc_t + \alpha_4{*}t + \alpha_5{*}prom_{1\,t} + \alpha_6{*}prom_{2\,t} + \alpha_7{*}prom_{3\,t} + \alpha_8{*}prom_{4\,t} + \alpha_9{*}d_t + \alpha_{10}{*}s_{1t} + \alpha_{11}{*}s_{2t} + \alpha_{12}{*}s_{3\,t},$$

where subscript t stands for time (week); q_t is per capita OJ gallon sales; p_{1t} and p_{2t} are CPI deflated

OJ and GJ prices, respectively; x_t is CPI deflated per capita income; $prom_{1t}$, $prom_{2t}$ and $prom_{3t}$ are OJ promotional variables for A/B ads, displays, and displays with ads; $prom_{4t}$ is a promotional variable for GJ A/B ads[1]; s_{1t} , s_{2t}, and s_{3t} are advertising stock variables for generic OJ advertising, brand OJ advertising and GJ advertising, respectively; d_t is a dummy variable taking a value of one after September 11, 2001; and the α's are parameters to be estimated.

In equation (1) and the subsequent Rotterdam model, we assume prices are fixed over the relatively short observation period of a week and consumers are price takers. Prices and advertising levels for other beverages and goods are additional variables that may help explain OJ volume sales in equation (1) and the Rotterdam model, but data on these variables were not available. The inclusion of the CPI in the demand equations of this study is a rough approach to account for price substitution between OJ and other goods.

Various lag structures might be used to model the effects of past advertising. In the present study a relatively simple lag structure was used given the rough measurement of the advertising available (each weekly GRP level is the quarterly level for that week). Given consumers have imperfect memories, less and less of some advertising message is expected to be remembered over time, and a geometric lag structure that focuses on the decay of the advertising message is used in this study. However, it should be noted that in some cases advertising may initially have a relatively small effect, before increasing and then eventually dissipating (following ,say, a second degree polynomial), but, given only quarterly advertising was known and the advertising level for each week was set at the corresponding quarter level, estimation of such lag structures would be problematic.

The advertising variables can be thought of as psychological stocks of past and present advertising. Over time advertising messages wear off and are assumed to be subject to a decay factor (λ) which indicates how much advertising is remembered and remains effective. Formally, the advertising stock variables are defined by

$$(2) \qquad s_{i\,t} = ad_{i\,t} + \lambda\, s_{i\,t-1}$$

or, by recursively substituting for $s_{i\,t-1}$ in equation (1),

$$(3) \qquad s_{i\,t} = \lambda^t s0_i + s1_{i\,t}, \quad i=1, 2, 3,$$

where ad_{it} is advertising of type i (generic OJ, brand OJ or total GJ) in week t; $s0_i$ is the stock of advertising in the week before the first sample observation in 1997; and $s1_{i\,t} = \sum_{j=0\ to\ t-1} \lambda^j ad_{i\,t-j}$ (see Brown and Lee, 1999). Note that the stock of advertising is composed of (1) the surviving pre-sample stock, $\lambda^t s0_i$, and (2) the surviving advertising created during the sample period, $s1_{i\,t}$.

Substituting expression (3) into equation (1) results in

---

[1] The promotional variables were provided by ACNielsen. Each of these variables measures the percentage of all commodity sales associated with the promotion in question.

(4) $q_t = \alpha_0 + \alpha_1 * p_{1t} + \alpha_2 * p_{2t} + \alpha_3 * inc_t + \alpha_4 * t + \alpha_5 * prom_{1t} + \alpha_6 * prom_{2t} + \alpha_7 * prom_{3t} + \alpha_8 * prom_{4t} + \alpha_9 * d_t + \alpha_{10} * s1_{1t} + \alpha_{11} * s1_{2t} + \alpha_{12} * s1_{3t} + \alpha_{13} \lambda^t$,

where $\alpha_{13} = \alpha_{10} * s0_1 + \alpha_{11} * s0_2 + \alpha_{12} * s0_3$.

In addition to being dependent on the variables on the-right-hand-side of equation (4), OJ gallon sales are also dependent on season of the year. Two approaches were used to allow for these demand changes. First, we allowed the intercept α_0 to vary by week by adding 51 weekly dummy variables to equation (4); this specification is referred to as the levels model. The other approach was by 52 nd differencing the data (for the 52 weeks in a year); this specification is referred to as the difference model.

Rotterdam Model

Our specification of advertising impacts in the Rotterdam model is based on Barten's (1977) fundamental matrix equation of consumer demand and follows the approach used in modeling advertising effects by Theil (1980a); Duffy (1987, 1989), and Brown and Lee (1997) among others.

Following Brown and Lee (1997), the demand equation for good i in the Rotterdam model can be written as (see Theil1975, 1976, 1980a,b for the general specification of Rotterdam model)

(5) $w_i \, d(\log q_i) = \theta_i \, d(\log Q) + \sum_{j \in A} \pi_{ij} \, (d(\log p_j) - \gamma ds_j - \gamma_a dsa - \gamma_b dsb) + \pi_{in} \, d(\log p_n)$

i=1 , . . . , n, (n = 5 in this study),
$j \in A$ is j = 1, ..., n-1 (the OJ categories),

where subscript i = 1, ..., 3 for the three major OJ brands (Minute Maid, Tropicana, Florida's Natural), i =4 for all other OJ, and i= 5 for a composite commodity for all other (non-OJ) goods; $w_i = p_i q_i / x$ is the budget share for good i, with p_i and q_i being the price and quantity of good i, respectively, and x being total expenditures or income; s_j is the stock of GRPs for brand j (j=1, 2, 3), sa is the stock of FDOC GRPs; $sb = s_1 + s_2 + s_3$ is the aggregate stock of GRPs for the three major brands; $\theta_i = p_i(\partial q_i / \partial x)$ is the marginal propensity to consume (MPC) for good i; $d(\log Q) = \sum w_i \, d(\log q_i)$ is the Divisia volume index or change in real income[2]; $\pi_{ij} = (p_i \, p_j / x) \, s_{ij}$ is the Slutsky coefficient, with $s_{ij} = (\partial q_i / \partial p_j + q_j \, \partial q_i / \partial x)$ being the $(i,j)^{th}$ element of the substitution matrix; and γ, γ_a, and γ_b are advertising coefficients. The Coefficients θ_i, π_{ij}, γ, γ_a and γ_b are treated as constants to be estimated. The advertising stocks for the other OJ category (ds_4) and the composite commodity (ds_5) are not available and treated as zero. The term $d(\log p_j) - \gamma ds_j - \gamma_a dsa - \gamma_b dsb$ can be thought of as an advertising adjusted price. As in the difference version of equation (4), the log differences $d(\log z_t) = \log z_t - \log z_{t-52}$ for general variable z, i.e., the variables were 52 nd differenced. The

---

[2] The Divisia volume index is a close approximation of $d(\log x) - \sum w_i \, d(\log p_i)$, as shown by Theil, 1971; $d(\log Q)$ is used instead of $d(\log x) - \sum w_i \, d(\log p_i)$ to insure adding-up.

advertising variables were level differenced (GRPs are based on percentages). The mean budget share between period t and t-52 was used to replace w_i for estimation.

The general restrictions on demand are (e.g., Theil 1980a,b)

(6a) adding up: $\sum_i \theta_i = 1;\ \sum_i \pi_{ij} = 0;$
(6b) homogeneity: $\sum_j \pi_{ij} = 0;$
(6c) symmetry: $\pi_{ij} = \pi_{ji}$.

Even assuming restrictions 6a, 6b and 6c hold, the number of coefficients in a demand system may be larger than can be precisely estimated, depending on the richness of the data used. In such cases, additional, plausible restrictions have been proposed (e.g., separability). In the present study, the time period analyzed is relatively short for measuring advertising effects, and, in equation (5), restrictions on the advertising coefficients have been imposed.

To see these restrictions note that the advertising coefficients are $\gamma = \partial \log (\partial u/ \partial q_j) /\partial s_j$, $\gamma_a = \partial \log (\partial u/ \partial q_j) /\partial sa$, and $\gamma_b = \partial \log (\partial u/ \partial q_j) /\partial sb$, that is, γ (γ_a or γ_a) is the percentage change in the marginal utility of good j for a change in the stock of advertising of brand j (FDOC or aggregate brand advertising). This specification is a restricted form of the Tintner-Ichimura-Basmann relationship in terms of the Rotterdam parameterization (see Selvanathan or Brown and Lee 1997, 2002).

Using the unrestricted Tintner-Ichimura-Basmann relationship, the unrestricted specification of advertising in the Rotterdam model can be written by replacing the first price term on the right hand side of equation (5) with

(7) $\sum_{j \in A} \pi_{ij} (d(\log p_j) - \sum_k \gamma_{jk}\, ds_k - \gamma_{ja} dsa)$

where $\gamma_{jk} = \partial \log (\partial u/ \partial q_j) /\partial s_k$ and $\gamma_{ja} = \partial \log (\partial u/ \partial q_j) /\partial\, sa$.

To obtain restricted specification (5), we assume that (a) a brand's advertising has a specific effect on its own utility and this effect is the same (γ) for each brand (Theil, 1980a); (b) brand advertising has a common generic effect on the marginal utilities of all OJ products (Brown and Lee, 2002); and (c) FDOC advertising has a similar but different generic impact. These assumptions can be summarized by

(8a) $\gamma_{jk} = \Delta_{jk}\, \gamma + \gamma_b$, j=1, ..., 4; k=1, ..., 3,

and

(8b) $\gamma_{ja} = \gamma_a$, j=1, ..., 4, where Δ_{jk} is the Kronecker delta, equal to unity if j=k, or zero, otherwise.

Rotterdam model (5) was estimated as in Brown and Lee (1997) and Duffy(1987) assuming a two stage budgeting process. The consumer price index (CPI) was used as the price for the composite commodity. The quantity of the composite commodity was real non-OJ expenditures, obtained by subtracting total OJ expenditures from disposable income and dividing the result by CPI. The quantities of all five goods were divided by the U.S. population, that is, per capita values were used. The four OJ goods were assumed to be block independent from the composite commodity. In the first stage of the budgeting process, total expenditures on the OJ group are determined based on the amount of real income, the prices of the four OJ goods, the CPI, the three brand advertising stocks and the FDOC advertising stock. Then in the second stage the conditional demand for each OJ good is determined based on the amount of income allocated to the OJ group in the first stage, the four OJ good prices, and the three brand advertising stocks. Changes in brand advertising can result in changes in the brand shares as well as changes in the amount of income allocated to the OJ group (the latter impact can be viewed as a brand, generic effect). Given FDOC advertising is assumed to effect the marginal utility of each OJ good in the same manner (see γ_a above), the impact of this type of advertising is zero on the conditional OJ demands (see Brown and Lee, 1997). That is, FDOC advertising is neutral in determining the conditional OJ brand, and its impact is purely generic in helping to determine the amount of income allocated to the OJ group in the first stage (this result also applies to the generic brand advertising effect γ_b).

With group A being the four OJ categories (i=1, ..., 4), sum (5) over group A to find aggregate demand for OJ

(9) $$d(\log Q_A) = \theta_A\, d(\log Q) + \sum_{j\in A} \pi_{Aj}\, (d(\log p_j) - \gamma ds_j - \gamma_a dsa - \gamma_b dsb) + \pi_{An}\, d(\log p_n),$$

where $d(\log Q_A) = \sum_{i\in A} w_i\, d(\log q_i)$, $\theta_A = \sum_{i\in A} \theta_i$ and $\pi_{Aj} = \sum_{i\in A} \pi_{ij}$.

Substituting (9) into (5) we find the conditional demand system for OJ brands to be

(10) $$w_i\, d(\log q_i) = \theta_i^*\, d(\log Q_A) + \sum_{j\in A} \pi_{ij}^*(d(\log p_j) - \gamma ds_j) \qquad i=1, \ldots, n-1,$$

where $\theta_i^* = \theta_i/\theta_A$ (a conditional MPC), and $\pi_{ij}^* = \pi_{ij} - \theta_i^*\, \pi_{Aj}$ (a conditional Slutsky coefficient). Due to block independence, π_{in} or, in the present analysis, $\pi_{i5} = -\phi\, \theta_i(1-\theta_A)$ and conditional Slutsky coefficient $\pi_{i5}^* = 0$ where ϕ is a factor of proportionality. Also note that the terms $\gamma_a dsa$ and $\gamma_b dsb$ vanish because they are part of each advertising adjusted OJ price and $\sum_{j\in A}\pi_{ij}^* = 0$ due to homogeneity property (6b).

Also, due to block independence, aggregate demand OJ demand (9) can be written as

(11) $$d(\log Q_A) = \theta_A\, d(\log Q) + \phi(1-\theta_A)\, \theta_A(\sum_{j\in A} \theta_j^*\, (d(\log p_j) - \gamma ds_j - \gamma_a dsa - \gamma_b dsb) - d(\log p_n)).$$

The demand system to be estimated is equations (10) and (11). Equation (11) indicates that the amount of real income allocated to the OJ category, $d(\log Q_A)$, depends on total real income $d(\log Q)$, and the overall advertising adjusted (Frisch) price for OJ, $\sum_{j \in A} \theta_j^*(d(\log p_j) - \gamma ds_j - \gamma_a dsa - \gamma_b dsb)$ relative to the price of the composite commodity $d(\log p_n)$. Increases in brand and generic advertising would be expected to decrease the advertising adjusted price $d(\log p_j) - \gamma ds_j - \gamma_a dsa - \gamma_b dsb$, with all the advertising coefficients (γ, γ_a and γ_b) expected to be positive. The terms $\gamma_a$dsa and $\gamma_b$dsb change all OJ category prices and result in generic impacts, for FDOC and brand GRPs, respectively. The term γds_j is a brand specific effect and just changes the adjusted price for brand j (however, these effects may result in increased expenditures on the OJ group like the pure generic impacts, $\gamma_a$dsa and $\gamma_b$dsb). When conditional real income $d(\log Q_A)$ is constant, equation (10) indicates the conditional demands for OJ brand depend on these specific effects and not the generic effects. The generic effects (and unconditional price, income and advertising effects) on the OJ categories are found by replacing $d(\log Q_A)$ in equation (10) with the left hand part of equation (11).

Single Equation Model Estimates

OJ demand equation (4) was estimated by ordinary least squares. The decay factor λ was set at .95 based on previous research (see Brown and Lee, 1997).

In preliminary analysis, the only significant variables in equation (4) were the price of OJ, FDOC advertising and the September 11 dummy (a variable was considered to be significant to the extent that its estimated coefficient was different from zero at the α=.10 level). Based on the F test, the price of GJ, the four promotional variables, and time or income but not both, can be omitted from the equation. Income and time, and the price of GJ to a somewhat lesser degree, were highly correlated (the correlation coefficient was .96 between time and income, and .89 between time and the price of GJ). The consequence of this multicollinearity problem is that precise estimates of the separate impacts of these variables on the demand for OJ can not be made. Hence, in further analysis, time, along with the four promotional variables and the price of GJ, were omitted from the equation. Income was kept as a measure of the information captured by the three relatively highly correlated variables. Hence, it should be recognized that the income impact on OJ demand in this case may be indicating the joint impacts of income and time, as well as perhaps the price of GJ. Although insignificant, the GRP variables for GJ and the major OJ brands were kept given the focus of the study.

Estimates of equation (4) under the above restrictions are shown in Table 2. The significant variables now include income and the pre-sample advertising stock, along with the price of OJ and FDOC advertising. The September 11 dummy was also significant but only in the levels model. Note that major-brand OJ advertising and GJ advertising do not significantly impact OJ demand. The signs for the significant coefficient are as expected—a negative OJ price coefficient (law of demand), positive income and FDOC advertising coefficients, and a negative coefficient for the September 11 dummy.

Single Equation Select OJ Demand Impacts

Based on the results in Table 2, estimates of the impacts on OJ gallons sales of the OJ price, income (income/time/GJ price), FDOC GRPs and the September 11 dummy variable were made. The last 52 weeks ending 11/24/01 were divided into four quarters and mean values were calculated by quarter for price, income and GRPs. The second quarter of the last 52 week period was selected to represent the situation before the decline in FDOC advertising and the fourth quarter and the end of the sample were chosen to represent the situation after the decline. The estimated coefficients were applied to the quarter-to-quarter (or second quarter-to-week) changes in these explanatory variables to estimate the impacts. The results are shown in Table 3.

Prices have been relatively flat in the past 52 weeks and the estimates in Table 3 suggest this variable has had little impact on demand over this period. On the other hand, the dummy variable results suggest that OJ demand has declined by about 1.7% to 2.7% since September 11. This may be due to the slowdown in the economy or changes in consumer behavior. Additionally, due to decreases in income, OJ demand may have declined another .4% to .5%. However, this impact is clouded by the multicollinearity situation which suggests that the estimated income coefficient may be capturing trend/ GJ price impacts. Lastly, the largest impact is that for FDOC advertising. The estimates suggest that the decline in FDOC advertising may have resulted in a 4% to 5% decline OJ demand.

The impact of FDOC advertising was also estimated by comparing predicted OJ volume sales over the sample weeks for two scenarios: with FDOC GRPs set at actual sample values versus with the GRPs set to zero (the remaining explanatory variables were held at sample values for both scenarios). Since we are comparing volume sales levels, the levels model was used; however, with the coefficient estimates for FDOC GRPs being virtually identical in the levels and difference models, the predicted FDOC advertising impacts on volume sales for theses two models were essentially the same. Aggregating the predicted volumes sales over the weeks studied for each advertising scenario, the OJ volume sales were found to be 5.1% greater with advertising versus without advertising.

Rotterdam Model Estimates

The term $d\lambda^t$ (see equation 3 for the definition variable λ^t) for pre-sample advertising were added to equations (10) and (11). Also, a constant term (for trends) was added to each conditional brand demand equation. In this model, the September 11 dummy was insignificant in explaining the demand for OJ and excluded (this result casts some doubt on the previously reported single equation estimate of the impact of this variable). Equations (10) and (11) were jointly estimated by the full information maximum likelihood method with symmetry and homogeneity imposed. As the data add up by construction, the error covariance matrix was singular and an arbitrary conditional demand equation was excluded (Barten,1969); the parameters for the excluded equation can be obtained using conditions (6) or by re-estimating the model omitting a different equation.

In preliminary analysis the brand advertising coefficient γ_b for basic generic effects was negative(the other advertising coefficients had the correct sign and were significant). This result was consistent with those for the single equation model. However, these estimated brand advertising impacts are probably spurious, and the possibility that brand advertising has a negative impact on the OJ category is rejected as implausible. Hence, γ_b was restricted to zero (this leads to a slightly higher FDOC generic effect). Estimates of model (10) and (11) are shown in Table 4, and elasticities are shown in Table 5.

In Table 4, 24 out of the 27 coefficients were statistically different from zero to the extent that each is twice or greater than its asymptotic standard error estimate; only a trend and two pre-sample advertising coefficients were insignificant. All own-Slutsky coefficient estimates were negative and significant as expected based on demand theory. The cross-Slutsky coefficient estimates were all positive and significant, indicating substitution relationships. The factor of proportionality ϕ was negative and significant, as expected (see, e.g., Theil 1975). All income coefficients were positive and significant indicating the OJ products are normal goods. The advertising coefficients were all positive and significant.

Table 5 shows the corresponding unconditional (uncompensated for prices) elasticities (at sample mean values) for Table 4. The brand specific income elasticities ranged from .5 to 1.2; and the brand specific own-price elasticities ranged from -1.1 to -2.5. All brand specific own-advertising elasticities were positive, while all cross-advertising elasticities were negative, suggesting competition between brands. The FDOC advertising elasticity was .037, suggesting that if the FDOC GRP stock declined from its sample average value to zero, OJ demand would decline by 3.7%. Similarly, without brand GRPs OJ demand would decrease by an estimated .3%.

Overall, the Rotterdam model advertising results were consistent with those for the single equation model, except the results for brand advertising. The additional information on separate brand sales suggested a positive, but relatively small, brand advertising impact on aggregate OJ sales in the Rotterdam model.

Concluding Comments

The results for both the single equation model and Rotterdam demand system suggest a relatively strong relationship between FDOC TV GRPs and OJ demand, but caution should be taken in interpreting this relationship. FDOC GRPs and merchandising tended to occur together, and the GRP advertising results may reflect the joint impact of these two types of advertising.

The brand advertising results also should be treated with some caution. One possibility that brand GRPs were insignificant in explaining OJ demand is that a brand advertising threshold level may exist to obtain any impact at all (for either brand and/or FDOC advertising), and once this threshold is passed there may be little or no further brand advertising impact within a range of additional advertising effort. The insignificant brand advertising results may simply reflect that we are analyzing such a post-threshold period. FDOC GRPs could still have an impact that is dependent on this threshold having been passed and there may be further brand advertising thresholds where larger brand/FDOC impacts could occur.

It should also be noted that brand GRPs may cause switching between 100% OJ product and less-than-100% juice drinks sold by the brand. The ACNielsen data studied covers only 100% OJ and would not capture this type of brand impact. Also, caution should be taken with respect to the merging of the quarterly brand GRPs, as well as the FDOC GRPs, with weekly sales data. In the present study, a constant advertising effort across the weeks in a quarter was assumed, as there is no information about weekly GRP levels; but it may be that this measure is too rough, throwing off the estimated brand advertising impact. Lastly, the different brand advertising may just not be sufficiently in sync---one week, perhaps only Tropicana advertises and then stops, then only Minute Maid advertises the next week and stops, followed by Florida Natural's advertising (the correlation coefficients between the three brand advertising stocks ranged from .18 to .55). The end result, as the Rotterdam model suggests, may be brand switching and little or no generic impacts.

Without further information, this study can not be definitive in answering many questions, but the strong relationship found between OJ gallon sales and FDOC advertising is an encouraging result for FDOC advertising programs.

References

Barten, A. P. (1969). "Maximum Likelihood Estimation of a Complete System of Demand Equations." *European Economic Review* 1:7-73.

Barten, A. P. (1977). "The Systems of Consumer Demand Functions Approach: A Review." *Econometrica* 45:23-51.

Basmann, R. L. (1956). "A Theory of Demand with Variable Preferences." *Econometrica* 24:47-58.

Brown, M., and Lee, J. (1997). "Incorporating Generic and Brand Advertising Effects in the Rotterdam Demand System." *International Journal of Advertising* 16:211-220.

Brown, M., and Lee, J. (1999). "Health and Nutrition Advertising Impacts on the Demand for OJ in Fifty Metropolitan Regions."*Journal of Food Products Marketing,* vol. 5: 31-47.

Brown, M., and Lee, J. (2002). "Restrictions on the Effects of Preference Variables in the Rotterdam Model." *Journal of Agricultural and Applied Economics*, forthcoming.

Duffy, M. H. (1987). "Advertising and the Inter-Product Distribution of Demand." *European Economic Review* 31:1051-1070.

Duffy, M. H. (1989). "Measuring the Contribution of Advertising to Growth in Demand: An Econometric Accounting Framework." *International Journal of Advertising* 8:95-110.

Ichimura, S. (1950-51). "A Critical Note on the Definition of Related Goods." *Review of Economic Studies* 18:179-183.

Selvanathan, E. A. (1989). "Advertising and Consumer Demand: A Differential Approach." *Economic Letters* 31:215-19.

Theil, H. (1971). *Principles of Econometrics.* New York: John Wiley & Sons, Inc. (North-Holland Publishing Company).

Theil, H. (1975). *Theory and Measurement of Consumer Demand*, Vol. I. Amsterdam: North-Holland Publishing Company.

Theil, H. (1976). *Theory and Measurement of Consumer Demand*, Vol. II. Amsterdam: North-Holland Publishing Company.

Theil, H. (1980a). *System-Wide Explorations in International Economics, Input-Output Analysis, and Marketing Research,* New York: North-Holland Publishing Company.

Theil, H. (1980b). *The System-Wide Approach to Microeconomics*, Chicago: University of Chicago Press.

Tintner, G. (1952). "Complementarity and Shifts in Demand." *Metroeconomica* 4:1-4.

Figure 1. OJ Gallons Vs. FDOC OJ GRPs
Weekly

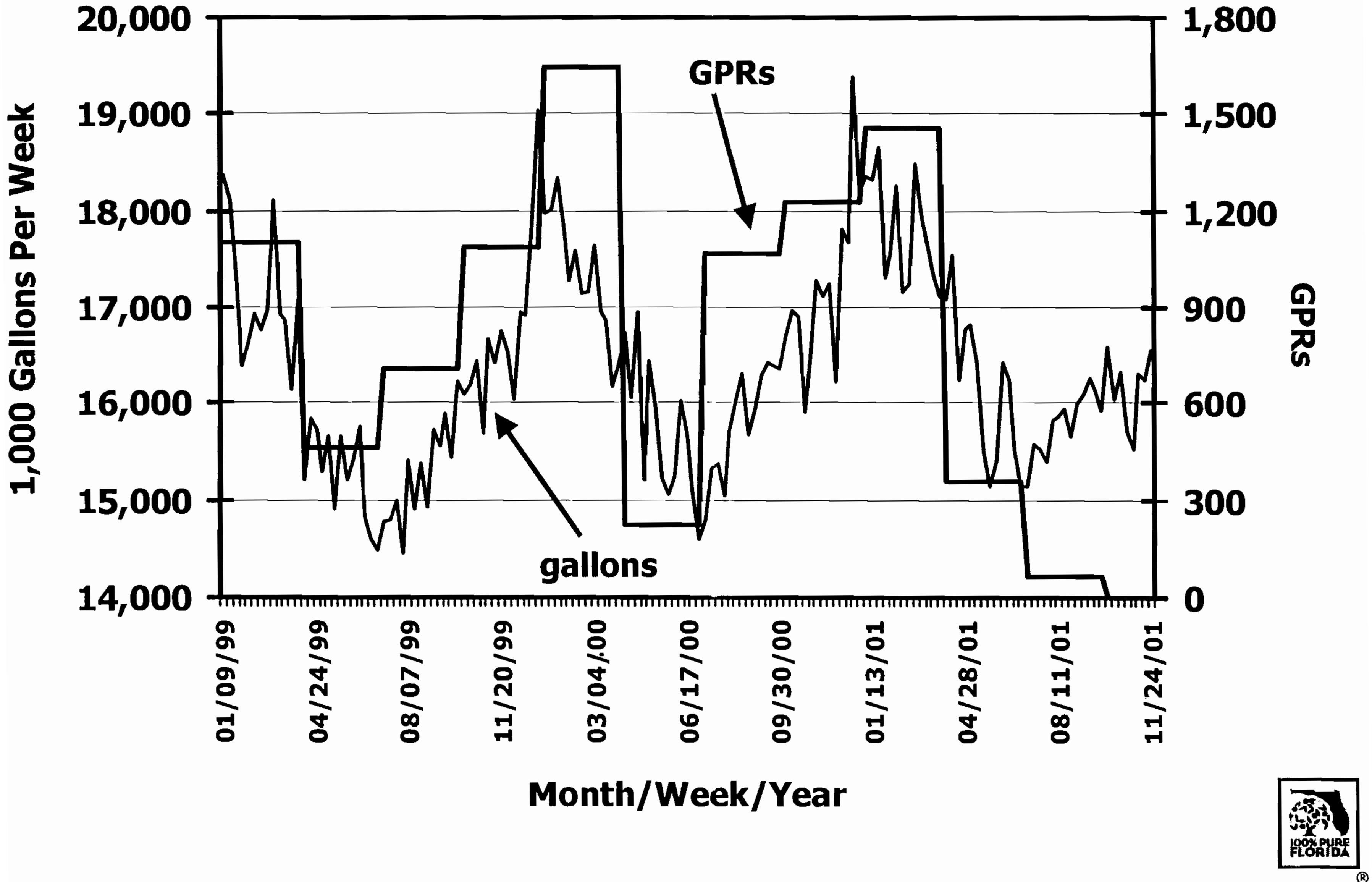


Figure 2. OJ Gallons Vs. FDOC OJ GRPs
52-Week Moving Averages

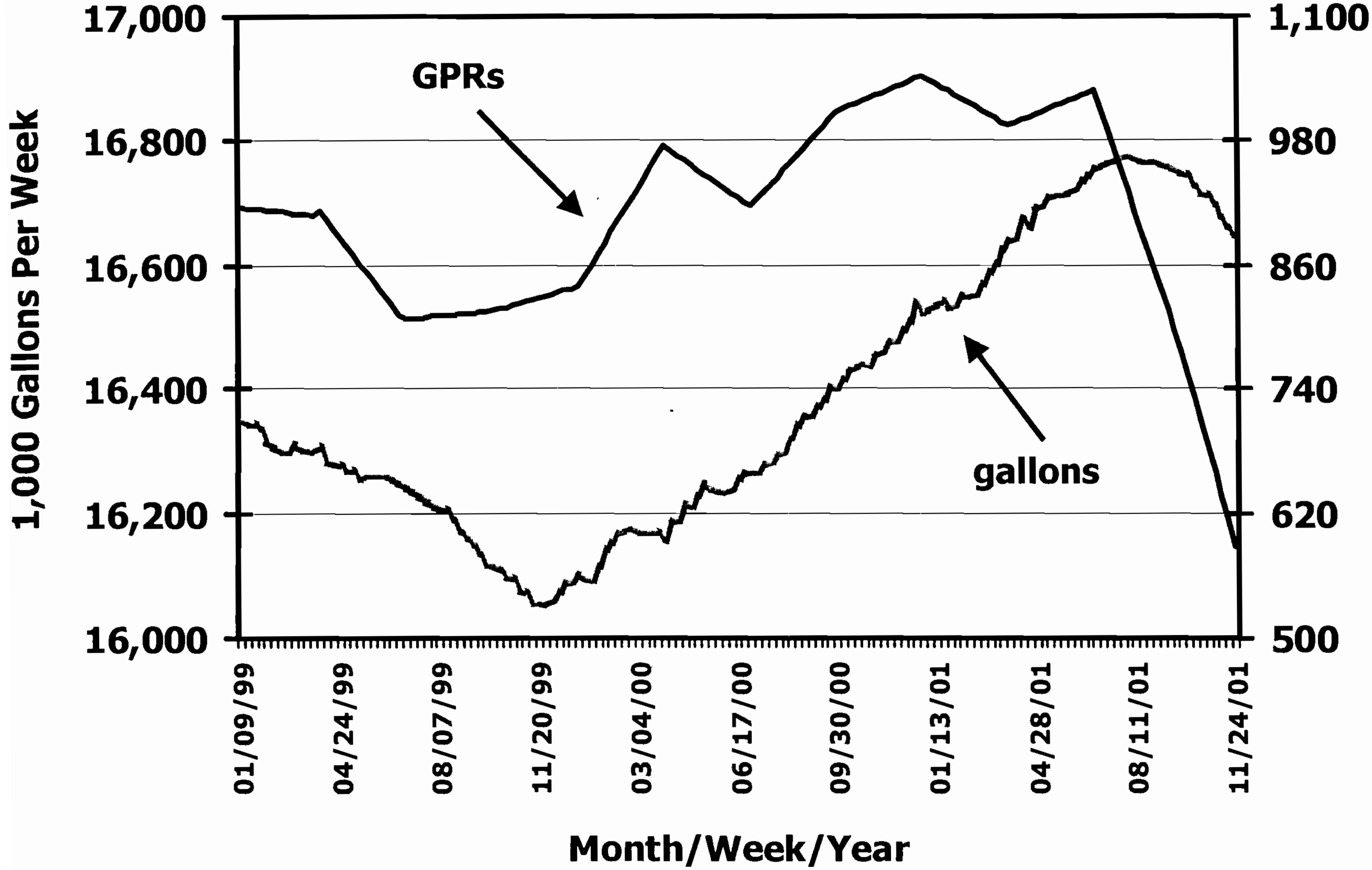
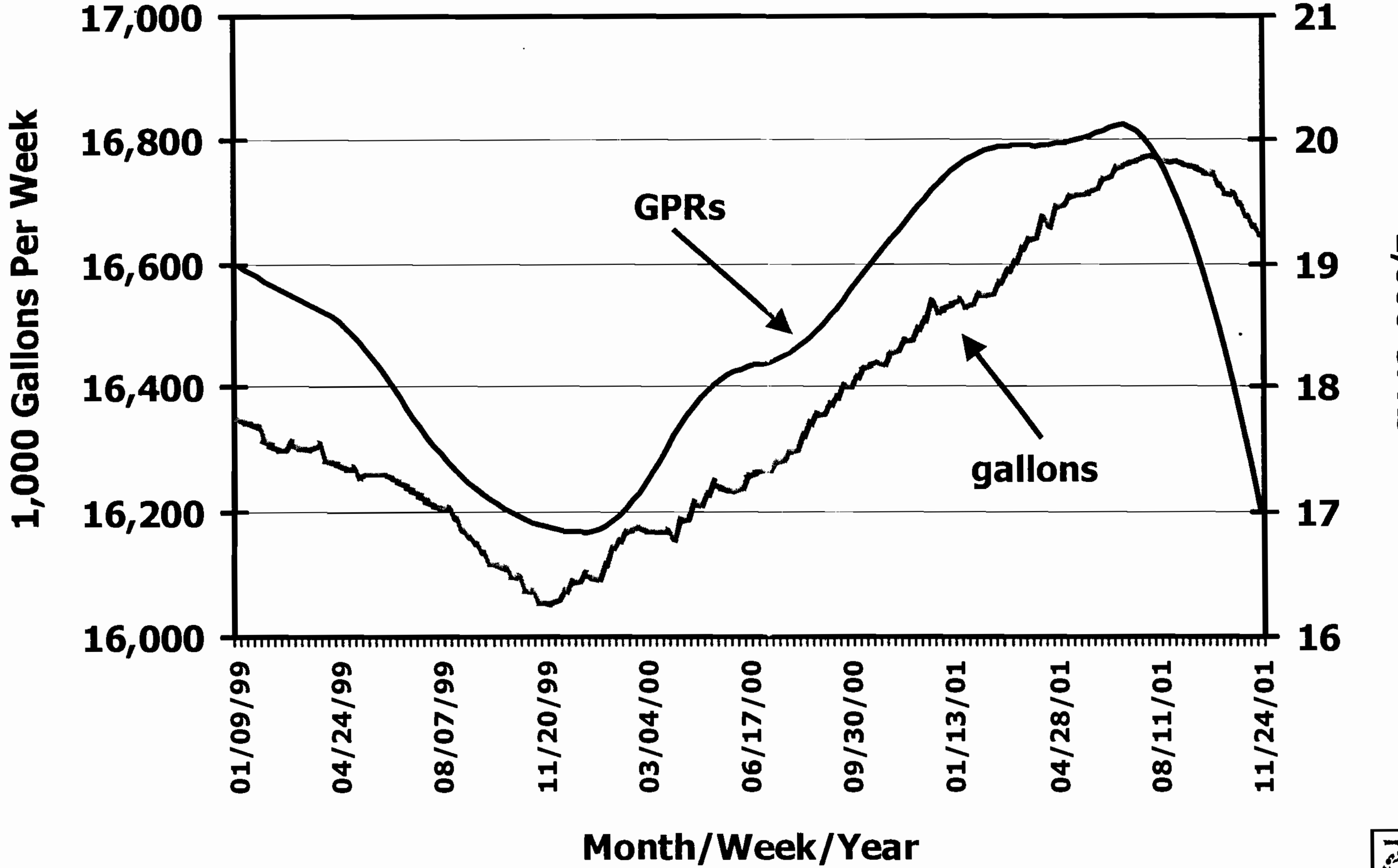


Figure 3. OJ Gallons Vs. FDOC OJ Stock* of GRPs

52-Week Moving Averages



* $Stock_t = GRP_t + .95\ Stock_{t-1}$ where t equals time (week).

Table 1. OJ Adverising Expenditures and Gross Rating Points.

OJ Media Expenditures (CMR).

FDOC

Year	Thou. $	% of Total
1997	$ 21,719	24.0%
1998	$ 18,943	23.9%
1999	$ 16,270	19.3%
2000	$ 22,118	21.6%
2001 (a)	$ 8,199	11.4%

Major Brand: Tropicana, Minute Maid, Florida Natural

Year	Thou. $	% of Total
1997	$ 68,925	76.0%
1998	$ 60,258	76.1%
1999	$ 68,148	80.7%
2000	$ 80,176	78.4%
2001 (a)	$ 63,988	88.6%

Total

Year	Thou. $	% of Total
1997	$ 90,644	100.0%
1998	$ 79,201	100.0%
1999	$ 84,418	100.0%
2000	$ 102,293	100.0%
2001 (a)	$ 72,188	100.0%

OJ Gross Rating Points (TV)

FDOC

Year	GRPs	% of Total
1997	3,572.7	26.6%
1998	3,940.6	27.4%
1999	3,467.1	24.2%
2000	5,088.3	35.3%
2001	2,294.9	20.3%

Major Brand: Tropicana, Minute Maid, Florida Natural

Year	GRPs	% of Total
1997	9,854	73.4%
1998	10,460	72.6%
1999	10,884	75.8%
2000	9,335	64.7%
2001	9,014	79.7%

Total

Year	GRPs	% of Total
1997	13,426	100.0%
1998	14,400	100.0%
1999	14,351	100.0%
2000	14,423	100.0%
2001	11,309	100.0%

(a) January through September.

Table 2. Restriced Per Capita OJ Demand Estimates, Based on ACNielsen Data for Stores Doing At Least $2 Million Sales Plus Super Centers.

		Model (a)	
		Levels (b)	**Difference**
Independent Variable (a)		Parameter Estimate	
OJ Price	OJ Price	-0.005285 *	-0.005887 *
Income	Income	9.0813E-05 *	7.18E-05 *
FDOC OJ Adv.	FDOC OJ Adv.	1.73E-07 *	1.73E-07 *
Brand OJ Adv.	Brand OJ Adv.	-1.82E-08	-6.25E-09
FDOC+Brand GJ Adv.	FDOC+Brand GJ Adv.	-4.12E-08	-5.87E-08
Pre-Sample Adv.	Pre-Sample Adv.	0.017649 *	0.013781 *
9/11 Dummy	9/11 Dummy	-0.001597 *	-0.001041
Durbin-Watson statistic		1.832	1.999
R-square		0.9203	0.4373

(a) The dependent variable is weekly per capita gallon sales of OJ.
(b) Parameter estimates for the intercept and weekly dummy variables are omitted for convenience.
* indicates that the parameter estimate is statistically difference than zero at the apha = .10 level.

Table 3. Select OJ Demand Impacts

Model		OJ Price	Income	FDOC OJ Adv.		9/11 Dummy
		$/CPI/Ga.	$/CPI/Person/ Week	GRPs		Ga./Person
		Parameter Estimate				
Levels	A	-0.0053	9.08E-05	1.73E-07	1.73E-07	-0.0016
Difference	B	-0.0059	7.18E-05	1.73E-07	1.73E-07	-0.0010
		Variable Change: Quarter or Week Mean Differences (a), (b)				
		Q4-Q3	Q4-Q3	Q4-Q2	11/24/01-Q2	11/24/01-Q2
	C	-0.01	-3.30	-14451	-16711	1
		Impact Estimate (Ga./Person/Week)				
Levels	D=A*C	0.0001	-0.0003	-0.0025	-0.0029	-0.0016
Difference	E=B*C	0.0001	-0.0002	-0.0025	-0.0029	-0.0010
		Mean Ga/Person/Week				
	F	0.06	0.06	0.06	0.06	0.06
		% Change in Mean Ga/Person				
Levels	G=D/F	0.1%	-0.5%	-4.2%	-4.8%	-2.7%
Difference	H=E/F	0.1%	-0.4%	-4.2%	-4.8%	-1.7%
		Elasticity at Sample Means (b)				
Levels	I=A*Mean/F	-0.22	0.43	0.05	0.05	
Difference	J=B*Mean/F	-0.24	0.34	0.05	0.05	

(a) Abbreviations for quarters are:
Q1 stands for quarter 1 running from week ending 12/02/00 through 2/24/01;
Q2 stands for quarter 2 running from week ending 3/03/01 through 5/26/01;
Q3 stands for quarter 3 running from week ending 6/02/01 through 8/25/01;
Q4 stands for quarter 4 running from week ending 9/01/00 through 11/24/01.

(b) Means were as follows:

Time Period	OJ Price $/Ga.	OJ Price $/CPI/Ga.	Income $/CPI/Person/ Week	FDOC OJ Adv. GRP Stock
Q1	4.33	2.47	288.4	22118
Q2	4.35	2.46	287.7	22719
Q3	4.42	2.49	293.2	14921
Q4	4.40	2.48	289.9	8268
11/24/2001	4.46	2.47	289.1	6008
Sample: 9/13/97---11/24/01	4.16	2.46	282.0	17834

Table 4. Full Information Maximum Likelihood Estimates of Equations (9) and (10).

Item			Product Category				
			OJ Group	A	B	C	D
OJ Group	MPC		3.62E-04				
	Price		-3.86E-01				
	Pre-Sample Ad		2.98E-05				
	FDOC Generic Ad		8.22E-06				
Group/ Brand	Brand Ad		8.54E-07				
Conditional	Brand MPC			0.3973	0.2800	0.0778	0.2449
	Slutsky Coeff.	A		-1.86E-04			
		B		6.85E-05	-2.04E-04		
		C		1.94E-05	4.62E-05	-9.04E-05	
		D		9.81E-05	8.89E-05	2.48E-05	-2.12E-04
	Brand Pre-Sample Ad			7.03E-06	4.05E-06 *	-3.26E-06 *	-7.82E-06
	Intercept			-4.91E-07 *	7.49E-06	1.84E-06	-8.84E-06
R-Square			0.37	0.63	0.74	0.62	0.68

Note: Each coefficent estimate was twice or greater than its corresponding standard error estimate, except as noted by a *.

Table 5. Select Rotterdam Model Elasticities

Item	Product Category				
	A	B	C	D	OJ Group
Income	1.174	0.533	0.760	0.502	
Price					
A	-1.700	0.279	0.406	0.479	
B	0.433	-1.129	1.164	0.450	
C	0.123	0.227	-2.462	0.126	
D	0.690	0.417	0.598	-1.249	
Other	-0.720	-0.327	-0.466	-0.308	
Brand Ad					
A	0.029	-0.005	-0.007	-0.008	0.002
B	-0.007	0.018	-0.018	-0.007	0.001
C	-0.001	-0.002	0.017	-0.001	0.000
FDOC Ad	0.063	0.029	0.041	0.027	0.037