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GENERIC ADVERTISING, FOB PRICE PROMOTION, AND FOB REVENUE: A CASE STUDY OF THE FLORIDA GRAPEFRUIT JUICE INDUSTRY

Jonq-Ying Lee

Each year many agricultural commodity groups spend millions of dollars advertising and promoting generic products. Generic advertising of a number of farm commodities occurs under federal authorization, under separate legislation or under marketing orders, or it is funded by producers on a voluntary contribution or mandatory basis.

More than three-fourths of the advertising programs operating under separate federal legislation or marketing order authority have been initiated during the past ten years (Armbruster). In addition to existing advertising programs, several advertising programs authorized under federal legislation were voted down by producers in a referendum: the most recent case was a beef referendum.

About 12,000 agricultural groups had promotional programs during the 1962 fiscal year, and 375 additional groups contributed funds to these active programs (Twining and Henderson). Parlett and Henderson indicated that slightly more than 900 groups spent $139 million on U.S. programs in 1972 and planned to spend $162 million in 1973.

There have been a number of studies of the impacts of generic promotion of farm commodities for specific situations. Most of these studies are analyses of retail markets (Ward, 1975; Hochman et al.; McClelland et al.) or a single equation analysis of a wholesale market (Thompson and Eiler); few of them have attempted to relate generic advertising with producers' revenues through retail sales (Ward, 1974).

For many years, Florida grapefruit growers have advertised and promoted the generic product grapefruit juice with the aid of an excise tax collected on the fruit processed. Prior to 1977–78 fiscal year, the excise tax was 10 cents per box of grapefruit; the tax was increased to 13 cents per box in 1979–80.

The Florida Department of Citrus (FDOC) spent more than $16 million on generic grapefruit juice advertising from the 1970–71 season to the 1979–80 season. Generic advertising of Florida processed grapefruit products and FOB price adjustments have been two major economic variables used by the industry to influence grapefruit juice movement. To implement these marketing strategies successfully, it is important to understand the effect of generic advertising programs, and price adjustments on FOB grapefruit juice movements and retail demand for grapefruit juice.

The objective of this study is to estimate the impact of generic advertising of processed grapefruit and FOB price adjustments on the FOB revenues to the Florida grapefruit processing industry. The basic relationship of retail demand and FOB movement to grapefruit juice prices and Florida generic advertising is discussed. An econometric model is formulated, and the estimated results from this model are used for analysis. The author believes that the approach utilized in this study could be used by other commodity groups for a similar study.

Generic Florida grapefruit advertising is designed to inform consumers of Florida grapefruit products. Although Florida is not the only supplier of grapefruit juice in this country, interest lies not only in the impact of Florida generic advertising on Florida FOB grapefruit juice movement, but also in the impact of juice movements for other suppliers, such as suppliers from Texas and California. However, grapefruit juice price and movement data for the suppliers in these areas are not available, hence, this study is restricted to only the advertising impact on the Florida grapefruit juice industry.

MODEL DEVELOPMENT

The general relationships of retail and FOB movements to prices, advertising, and other factors are illustrated with the aid of the flow chart shown in Figure 1. Initially, at the FOB level, a price of grapefruit juice is established on the basis of conditions affecting crop size, and on the amount of grapefruit juice on hand in inventories (Ward, 1974). The major force in the pricing mechanism is processor actions. On the supply side for a given year, the pack of grapefruit juice is determined by the crop size, and the amount packed is subject to seasonal variations. This relationship is formulated as equation 1 in Table 1.

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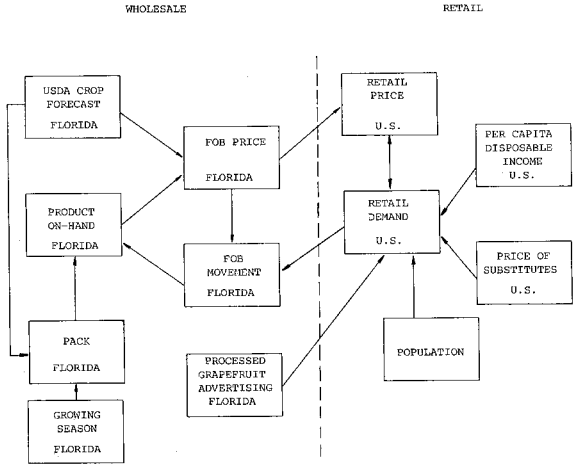

FIGURE 1. Flow Chart Showing the Relationship of Grapefruit Juice Movements to Pricing and Advertising

The pack during a quarter plus the inventory of grapefruit juice at the beginning of the quarter minus the movement (FOB demand) determines the inventory level at the end of the quarter. The relationship is written as equation 2 in Table 1.

At the processor market level, the crop forecast from the U.S. Department of Agriculture is expected to affect processor pricing. For example, given an increase in the crop forecast, *ceteris paribus,* processors would be expected to reduce current prices in an effort to minimize the effect of expected larger supplies in the future. On the other hand, a large inventory is expected to force processors to reduce current prices to increase FOB movements. As indicated above, pack through the entire year varies from season to season, and during the peak harvest season, one should expect to have a higher inventory than in other seasons. In addition, processors usually interpret their inventory in terms of weeks of supply. The supplies on hand during different seasons may transmit different pricing information to processors. Equation 3 in Table 1 is developed to capture major factors that may affect processors' pricing decisions.

Note that the ending inventory would have the information contained by variables EI_{t-1}, PK_t, and $MOVE_t$. One would expect that beginning inventory (EI_{t-1}) and juice packed through the quarter (PK_t) would have the same effect on FOB price.

In this study, the FOB movement is considered as derived from retail demands. Retailers and reprocessors replenish their supplies from wholesalers as sales occur. For given retail demands, the rate at which grapefruit juice moves from wholesale suppliers to retailers and reprocessors depends on the FOB price. The higher the price, the lower the expected movement. The relationship can be written as equation 4 in Table 1.

In setting a retail grapefruit juice price, this study assumes that the decision is affected both by cost-push and demand-pull forces. The cost of grapefruit juice for retailers is the price they pay for the product. Retailers add a markup to their cost, and the size of the markup depends in part on their view of the demand-and-supply situation. That is, they can increase retail price when retail demand is strong, and decrease retail price when retail demand is weak to maintain a certain level of revenue (Penrose; Baumol; Marris; Williamson). The relationship can be presented as equation 5 in Table 1.

There is considerable discussion in the literature concerning the proper response variable to use when measuring advertising effectiveness. Many people argue that sales increases resulting from advertising expenditures cannot be measured directly for various reasons. They argue for measuring changes in variables such as advertising awareness, advertising and product recall, and consumer attitude toward the product as proxies for sale. The assumption here is that variables such as awareness, recall,[1] and so on, are highly correlated with actual sales levels. This assumption may or may not be valid, depending on the peculiar characteristics of the product.

The position taken herein is that the response variable should be actual sales levels. That is, advertising effectiveness is measured in this study by its effectiveness in increasing either dollar sales or quantity sales.

The Florida Department of Citrus experience is somewhat unique in that (1) the department has good time-series data on sales, prices, and generic advertising expenditures; and (2) the advertising costs are not expended as a fixed percent of retail sales dollars. These conditions have permitted enough independent variability in the data to identify the advertising response rates after the effects of other variables such as prices and incomes have been netted out.

Advertising has a direct effect on the consumer, hence the retail demand for grapefruit juice. In building a quantitative model to evaluate Florida processed grapefruit advertising programs, the following hypotheses were considered: (1) there would be some positive demand response to advertising effort, and the response would decrease as advertising efforts were increased; and (2) the effect of a given advertising effort would be distributed over time. One major objective of the research was to evaluate the im-

[1] The author failed to establish the relationship between the levels of generic advertising and advertising recall, and the relationship between juice consumption and the level of advertising recall, which leads to the position of using actual sales levels as the response variable.

TABLE 1. Linear Form of Econometric Model of Grapefruit Juice Retail and FOB Level Purchases and Prices[a]

Equation Number	Equation Description	Endogenous Variables										Predetermined Variables											
		PK_t	EI_t	PW_t	$HAND_{1t}$	$HAND_{2t}$	$HAND_{3t}$	$HAND_{4t}$	$MOVE_t$	PR_t	QR_t	$FORE_t$	S_1	S_2	S_3	EI_{t-1}	POR_t	I_t	$ADV_t^{1/2}$	$ADV_{t-1}^{1/2}$	$ADV_{t-2}^{1/2}$	$ADV_{t-3}^{1/2}$	Intercept
1	Processor Pack (PK_t)	-1										β_{11}	β_{12}	β_{13}	β_{14}								β_{10}
2	Ending Inventory (EI_t)	1	-1						-1							1							
3	Wholesale Pricing (PW_t)			-1	γ_{34}	γ_{35}	γ_{36}	γ_{37}				β_{31}											β_{30}
3.1	Juice On-Hand ($HAND_{1t}$)		b		-1				b														
3.2	Juice On-Hand ($HAND_{2t}$)		b			-1			b														
3.3	Juice On-Hand ($HAND_{3t}$)		b				-1		b														
3.4	Juice On-Hand ($HAND_{4t}$)							-1	b														
4	Wholesale Demand ($MOVE_t$)			γ_{43}					-1		γ_{410}												β_{40}
5	Retail Pricing (PR_t)			γ_{53}						-1	γ_{510}												β_{50}
6	Retail Demand (QR_t)									γ_{69}	-1					β_{66}	β_{67}		λ_1	λ_2	λ_3	λ_4	β_{60}

[a] Variable definitions and data sources:

PK_t Grapefruit juice packed from fruit, million single strength equivalent (SSE) gallons (Florida Citrus Processors Association).

EI_t Ending juice inventory for quarter t, million SSE gallons (Florida Citrus Processors Association).

PW_t Composite FOB grapefruit juice price deflated by consumer price index (CPI) for quarter t, ¢/gallon (FDOC).

$HAND_{it}$ Ending inventory in terms of quarters of juice supply for quarter t, i=1,2,3,4 for the first, second, third and fourth quarter of a year, respectively. $HAND_{1t}=EI_t/MOVE_t$, if t is the first quarter of a year, otherwise $HAND_{1t}=0$; $HAND_{2t}=EI_t/MOVE_t$, if t is the second quarter of a year, otherwise $HAND_{2t}=0$; and so on.

$MOVE_t$ FOB grapefruit juice movements for quarter t, million SSE gallons (Florida Citrus Processors Association).

PR_t Composite retail grapefruit juice price deflated by CPI during quarter t, ¢/SSE gallon (Marketing Research Corporation of America).

QR_t Per capita consumption of grapefruit juice during quarter t, ounce/capita (Marketing Research Corporation of America).

$FORE_t$ Average of monthly U.S. Department of Agriculture crop forecast for Florida grapefruit during quarter t, million boxes (Florida Crop and Livestock Reporting Service).

S_1, S_2, S_3 Zero-one dummy variable for the second, third and fourth quarters, respectively.

POR_t Composite retail orange juice price deflated by CPI during quarter t, ¢/SSE gallon (Marketing Research Corporation of America).

I_t Per capita disposable income during quarter t, dollars (U.S. Department of Commerce).

ADV_{t-j} Florida processed grapefruit generic advertising expenditures deflated by the index of cost per thousand household reached (Advertising Age) dollars (FDOC).

[b] See definition of $HAND_{it}$ in a.

pact of advertising expenditures on a "real" dollar basis. Thus, a means of adjusting the data for increases in the costs of advertising was needed. The index used in this study is one that measures the real advertising purchasing power of a dollar of advertising expenditure over time, i.e., the CPM index or cost per 1000 households reached.[2] This index incorporates an adjustment for increased efficiency as actual unit advertising costs go up.

In addition to the effect of Florida generic advertisements, the retail demand for grapefruit juice also changes as income, population, the price of grapefruit juice, and the prices of substitutes change. The retail demand relationship used in this study was specified as equation 6 in Table 1.

Where λ_{j+1} has the following structure:

$$\lambda_{j+1} = \beta_{68} + \beta_{69}(j)^{1/2}, \; j=0,1,2,3.$$

This lag structure has properties of the geometric decay function (Ward and Myers)

$$\frac{\partial \lambda_{j+1}}{\partial j} < 0 \text{ and } \frac{\partial^2 \lambda_{j+1}}{\partial j^2} > 0$$

assuming $\beta_{68}>0$ and $\beta_{69}<0$, and can be estimated using the Almon lag procedures (Cooper). Allowing for the Almon lagged structure equation (6) can be written as:

$$(6.1) \quad QR_t = \beta_{60} + \Gamma_{69}PR_t + \beta_{66}POR_t + \beta_{67}I_t + \beta_{68}Z_{it} + \beta_{69}Z_{2t} + \varepsilon_{6t}$$

And Z_{it}'s follow from the Almon procedure where[3]

$$Z_{1t} = ADV_t^{1/2} + ADV_{t-1}^{1/2} + ADV_{t-2}^{1/2} + ADV_{t-3}^{1/2}$$

$$Z_{2t} = ADV_{t-1}^{1/2} + 1.4142ADV_{t-2}^{1/2} + 1.73205ADV_{t-3}^{1/2}$$

RESULTS

The data used to estimate the model are from several major sources. Retail demand and prices information is provided by the Marketing Research Corporation of America through a contract with the Florida Department of Citrus. FOB movement, price and pack information is obtained from the statistical reports published by the Florida Citrus Processors Association. Crop forecasts are collected from reports by the Florida Crop and Livestock Reporting Service. Generic advertising expenditure data were obtained from Florida Department of Citrus invoices. Data from the first quarter of 1971 through the second quarter of 1978 were used in this study.

Structural coefficient estimates and their associated asymptotic standard errors are shown in Table 2. In general, the signs of the coefficients are consistent with *a priori* expectations, and all but two coefficients are asymptotically significant at 20 percent level or above (Goldberger, pp. 331–36). The coefficients were estimated with two-stage least squares.[4]

The estimated relation for the pack equation indicates that (1) for every million boxes increase in the USDA crop forecast, the grapefruit juice packed from fruit would be increased by .69 million SSE gallons; and that (2) the packing activity is highly seasonal, with most of the packing done in the first quarter of each year, and the least during the third quarter of each year, which is consistent with the practices of the Florida grapefruit industry.

In the wholesale pricing equation, results show that the FOB price was negatively related to the size of USDA crop forecast and product on hand during different quarters throughout the year. As shown by the estimated structural form parameters in this equation, a high inventory in the third and fourth quarter of a year had the most negative impact on FOB price. The estimated price flexibility for the first, second, third, and fourth quarter of a year is −.5430, −.5581, −.5293, and −.4664, respectively. The estimated price flexibility with respect to USDA crop forecast at sample means is −1.0340. The USDA crop forecast could be considered as expected supply, as opposed to the realized supply given by variables $HAND_1$ through $HAND_4$. The results suggest that processors were more responsive to USDA crop forecast than to their realized supplies.

As mentioned above, FOB movement is considered to be derived from retail demand, therefore the movement should be positively related to retail demand and negatively related to FOB grapefruit juice price. The estimated equations support this hypothesis. As indicated by the wholesale demand equation in Table 2, every one-ounce increase (decrease) in retail demand per capita would cause FOB movement to increase (decrease) by 2.75 million SSE gallons. The insignificant relationship between FOB price and movement suggests that most of the FOB movement was used to replenish depleted retail inventory and that retailers did not take advantage of lower price to stock up their supplies.

The results for the retail pricing equation show that the retail price is positively related to FOB price and the retail demand for grapefruit juice.

[2] This is an index for all media.

[3] Different length of lags and functional forms were tried. The best result, in terms of theoretical interpretation, asymptotic t-test and mean squares of error was the one shown.

[4] Because equations 3.1 through 3.4 are nonlinear, three-stage least squares method was not tried.

TABLE 2. Structural Form Parameters and Associated Standard Errors[a]

Equation Number	Equation Description	Endogenous Variables										Predetermined variables														
		PK_t	EI_t	PW_t	$HAND_{1t}$	$HAND_{2t}$	$HAND_{3t}$	$HAND_{4t}$	$MOVE_t$	PR_t	QR_t	$FORE_t$	S1	S2	S3	EI_{t-1}	POR_t	I_t	$ADV_t^{1/2}$	$ADV_{t-1}^{1/2}$	$ADV_{t-2}^{1/2}$	$ADV_{t-3}^{1/2}$	Intercept	Mean	MSE
1	Processor Pack (PK_t)	-1										.6874 (.3747)	-30.3438 (3.7201)	-59.8875 (3.8512)	-42.4529 (3.7832)								30.6220 (17.8651)	31.0249	55.3544
2	Ending Inventory (EI_t)	1	-1						-1							1								1.6452	
3	Wholesale Pricing (PW_t)			-1	-19.0547 (5.4393)	-19.7254 (5.4666)	-28.6886 (8.1700)	-28.5515 (9.1537)			-1.6268 (.3973)												186.2578 (23.2894)	71.4179	61.9027
3.1	Juice On-Hand ($HAND_{1t}$)		b		-1				b															2.0352	
3.2	Juice On-Hand ($HAND_{2t}$)		b			-1			b															2.0204	
3.3	Juice On-Hand ($HAND_{3t}$)		b				-1		b															1.2008	
3.4	Juice On-Hand ($HAND_{4t}$)		b					-1	b															1.1664	
4	Wholesale Demand ($MOVE_t$)			-.0417 (.1013)					-1		2.7503 (.8028)												13.7534 (14.4888)	27.8399	6.5277
5	Retail Pricing (PR_t)			1.2516 (.1065)						-1	.9109 (.8844)												-1.8542 (15.2385)	96.4925	7.2207
6	Retail Demand (QR_t)									-.2491 (.0829)	-1						.1321 (.0552)	-.0087 (.0045)	.0019 (.0006)	.0013 (.0004)	.0010 (.0004)	.0008 (.0005)	52.4913 (19.3792)	9.8392	.5317

[a] Variable definitions and data sources:

- PK_t Grapefruit juice packed from fruit, million single strength equivalent (SSE) gallons (Florida Citrus Processors Association).
- EI_t Ending juice inventory for quarter t, million SSE gallons (Florida Citrus Processors Association).
- PW_t Composite FOB grapefruit juice price deflated by consumer price index (CPI) for quarter t, ¢/gallon (FDOC).
- $HAND_{it}$ Ending inventory in terms of quarters of juice supply for quarter t, i=1,2,3,4 for the first, second, third and fourth quarter of a year, respectively. $HAND_{1t}=EI_t/MOVE_t$, if t is the first quarter of a year, otherwise $HAND_{1t}=0$; $HAND_{2t}=EI_t/MOVE_t$, if t is the second quarter of a year, otherwise $HAND_{2t}=0$; and so on.
- $MOVE_t$ FOB grapefruit juice movements for quarter t, million SSE gallons (Florida Citrus Processors Association).
- PR_t Composite retail grapefruit juice price deflated by CPI during quarter t, ¢/SSE gallon (Marketing Research Corporation of America).
- QR_t Per capita consumption of grapefruit juice during quarter t, ounce/capita (Marketing Research Corporation of America).
- $FORE_t$ Average of monthly U.S. Department of Agriculture crop forecast for Florida grapefruit during quarter t, million boxes (Florida Crop and Livestock Reporting Service).
- S_1,S_2,S_3 Zero-one dummy variable for the second, third and fourth quarters, respectively.
- POR_t Composite retail orange juice price deflated by CPI during quarter t, ¢/SSE gallon (Marketing Research Corporation of America).
- I_t Per capita disposable income during quarter t, dollars (U.S. Department of Commerce).
- ADV_{t-j} Florida processed grapefruit generic advertising expenditures deflated by the index of cost per thousand household reached (Advertising Age) dollars (FDOC).

[b] See definition of $HAND_{it}$ in a.

Every one-cent change in FOB price would cause an estimated 1.25 cent change in retail price. The FOB-retail price transmission elasticity[5] estimated from structural-form parameter at sample means is .93 percent. Retail demand also has a role in determining retail price, as shown in Table 2; however, the estimated standard error indicates very low statistical confidence that the parameter is different from zero.

In the retail demand equation, prices, income, and generic advertising variables were found to be important determinants of per capita consumption of grapefruit juice. Using the structural form parameter, the own-price elasticity[6] of demand was calculated to be −2.44. This implies that a 1-percent decrease (increase) in retail price would result in a 2.44 percent increase (decrease) in grapefruit juice consumed. This result suggests that the grapefruit juice retail market is price elastic.

The cross-price elasticity calculated from the structural form parameter is 1.14. This indicates that as orange juice price increases (decreases) by 1 percent, the consumption of grapefruit juice would increase (decrease) by 1.14 percent. In other words, orange juice and grapefruit juice are strong substitutes at the retail market level.

The per-capita quarterly consumption of grapefruit juice increased from less than 7.5 ounces in 1971 to more than 10.0 ounces in 1978; during the same period, the deflated retail grapefruit juice price decreased steadily from more than $1.13 per SSE gallon in 1971 to less than $0.90 per SSE gallon in 1978. The retail consumption net of price and advertising effects results in a negative trend that is captured by income variable. A trend variable was added to the retail demand function to isolate the negative trend, but because of high correlation (0.93) between income and trend variable, the effort was unsuccessful. The income elasticity calculated from structural form parameter is −3.25. If the true coefficient were actually negative, grapefruit juice would be defined as an inferior good, i.e., as income increases, the per capita consumption of grapefruit juice would decrease; and, with our results, a 1-percent increase in income would cause the consumption of grapefruit juice to decrease by 3.25 percent.

The estimated results suggest that generic grapefruit juice advertising expenditures had significant positive effect on retail sales of grapefruit juice for three quarters beyond the quarter during which the advertising actually occurred (Table 2). The major effect of generic advertising effort was realized in the quarter when the advertising occurred, with subsequent declines in the advertising gains. About 38 percent of the total response appears during the quarter when the advertising occurred, and about 26 percent of the response is seen one quarter later. The effect gradually dissipates each quarter for three quarters. These are direct effects.

The structural coefficients indicate only the direct effects of a variable on a dependent variable, assuming that other variables were held constant. However, a change in the USDA crop forecast would have an effect on juice packed from fruit, and the impact of crop forecast could be felt through the entire system, i.e., the USDA crop forecast would have an impact on the FOB price, which in turn would have an impact on the FOB movement, retail price, and retail demand. At the same time, retail demand has an effect on retail price, which in turn affects FOB movement, and FOB movement determines ending inventory and juice on hand in terms of quarters of supply, and so on. In order to evaluate the net effect of this chain reaction from a change in an exogenous variable, reduced form equations should be used. The reduced form parameter is a multiplier that indicates the total effect of a change in an exogenous variable on an endogenous variable, after taking account of the interdependences among the current endogenous variables.

With a model linear in the variables, the reduced form equations of a model that consists of a set of simultaneous "linear" equations can be obtained by simply matrix operations. However, the reduced form equations of a model nonlinear in the variables, such as identities (3.1) through (3.4) as used in equation (3), cannot be obtained by simple matrix operations. Taylor's series expansion (Womack and Matthews) was used to linearize the nonlinear relationship specified in this model. Four different sets of reduced form equations were derived for the four quarters, respectively. The linear approximation of inventory variables was Taylor's series expansion about sample means of EI and MOVE. The reduced form equations are presented in Tables 3 through 6.

The reduced form parameters indicate that generic advertisements have positive effects on retail demand, retail price, FOB movement, and FOB price. The major effect of generic advertisements is realized during the quarter when the advertisings occurred, the effect gradually dissipating each quarter for three quarters. On the other hand, generic advertising has negative effect on juice supplies and ending inventory.

Composite orange juice retail price has a positive effect on retail demand, retail price, FOB movement, and FOB price of grapefruit juice, which indicates the two are substitutes, i.e.,

[5] The FOB-retail transmission elasticity is defined as $\frac{\partial PR}{\partial PW} \cdot \frac{PW}{PR}$.

[6] All elasticities and flexibilities were estimated at sample means. Ward (1974) showed that CSSGJ was highly price inelastic. This difference may be caused by (1) in Ward's study, only CSSGJ was included, while current study all grapefruit juice was studied; (2) in Ward's study, annual observations were used and in current study, quarterly observations were used.

TABLE 3. Reduced Form Parameters (First Quarter) About Sample Average

Predetermined Variable	Equation: Pack from Fruit PK_t	Ending Inventory EI_t	Wholesale Pricing $MOVE_t$	Juice Supply $HAND_{1t}$	Wholesale Demand $MOVE_t$	Retail Pricing PR_t	Retail Demand QR_t
I_t		-.0081	-.0155	.0008	-.0081	-.0223	-.0032
ADV_t		-.0017	.0033	-.0002	.0017	.0048	.0007
ADV_{t-1}		-.0012	.0023	-.0001	.0012	.0032	.0005
ADV_{t-2}		-.0009	.0018	-.0001	.0009	.0026	.0004
ADV_{t-3}		-.0008	.0015	-.0001	.0008	.0022	.0003
POR_t		-.1225	.2343	-.0123	.1225	.3371	.0481
$FORE_t$	.6874	.0555	-.8532	-.0406	.6319	-.8704	.2168
EI_{t-1}		.8059	-.2621	.0138	.1941	-.2674	.0666
Intercept	30.6219	20.144	148.409	1.9863	10.4779	191.871	4.6924

TABLE 4. Reduced Form Parameters (Second Quarter) About Sample Average

Predetermined Variable	Equation: Pack from Fruit PK_t	Ending Inventory EI_t	Wholesale Pricing $MOVE_t$	Juice Supply $HAND_{2t}$	Wholesale Demand $MOVE_t$	Retail Pricing PR_t	Retail Demand QR_t
I_t		.0079	-.0157	.0008	-.0079	-.0225	-.0031
ADV_t		-.0017	.0034	-.0002	.0017	.0048	.0007
ADV_{t-1}		-.0011	.0023	-.0001	.0011	.0033	.0005
ADV_{t-2}		-.0009	.0018	-.0001	.0009	.0026	.0004
ADV_{t-3}		-.0008	.0015	-.0001	.0008	.0022	.0003
POR_t		-.1196	.2383	-.0121	.1196	.3411	.0471
$FORE_t$	.6874	.0667	-.8381	-.0400	.6207	-.8548	.2130
EI_{t-1}		.8051	-.2632	.0133	.1949	-.2685	.0669
Intercept	.2781	-4.8300	155.660	1.5512	5.1081	199.268	2.8498

TABLE 5. Reduced Form Parameters (Third Quarter) About Sample Average

Predetermined Variable	Equation: Pack from Fruit PK_t	Ending Inventory EI_t	Wholesale Pricing $MOVE_t$	Juice Supply $HAND_{3t}$	Wholesale Demand $MOVE_t$	Retail Pricing PR_t	Retail Demand QR_t
I_t		.0068	-.0173	.0006	-.0068	-.0241	-.0027
ADV_t		-.0015	.0037	-.0001	.0015	.0052	.0006
ADV_{t-1}		-.0010	.0025	-.0001	.0010	.0035	.0004
ADV_{t-2}		-.0008	.0020	-.0001	.0008	.0028	.0003
ADV_{t-3}		-.0007	.0017	-.0001	.0007	.0023	.0003
POR_t		-.1024	.2614	-.0091	.1024	.3647	.0412
$FORE_t$	.6874	.0776	-.8234	-.0280	.6098	-.8400	.2092
EI_{t-1}		.7194	-.3789	.0131	.2806	-.3985	.0963
Intercept	-29.2655	-24.7623	168.630	.6142	-4.5032	212.506	-.4482

TABLE 6. Reduced Form Parameters (Fourth Quarter) About Sample Average

Predetermined Variable	Equation: Pack from Fruit PK_t	Ending Inventory EI_t	Wholesale Pricing $MOVE_t$	Juice Supply $HAND_{4t}$	Wholesale Demand $MOVE_t$	Retail Pricing PR_t	Retail Demand QR_t
I_t		.0068	-.0173	.0006	-.0068	-.0241	-.0027
ADV_t		-.0015	.0037	-.0001	.0015	.0052	.0006
ADV_{t-1}		-.0010	.0025	-.0001	.0010	.0035	.0004
ADV_{t-2}		-.0008	.0020	-.0001	.0008	.0028	.0003
ADV_{t-3}		-.0007	.0017	-.0001	.0007	.0023	.0003
POR_t		-.1025	.2614	-.0092	.1025	.3647	.0412
$FORE_t$	.6874	.0626	-.8437	-.0274	.6243	-.8606	.2144
EI_{t-1}		.6977	-.4082	.0143	.3023	-.4164	.1037
Intercept	-11.8309	-14.1012	159.492	.4712	2.2703	203.176	1.8760

when the price of orange juice increases, the consumption of grapefruit juice also increases. This increase in grapefruit juice consumption would decrease its juice supplies and ending inventory, which is also shown in Tables 3 through 6.

The crop forecast by the USDA has a negative effect on FOB price and retail price. As mentioned above, FOB price is more sensitive to USDA crop forecast than to actual juice supplies on hand: an increase in crop forecast would decrease the FOB price. As FOB price decreases, retailers may pass their savings to consumers, hence a decrease in the retail price. The ending inventory of the previous quarter has an effect on FOB and retail prices that is similar to the USDA crop forecasts.

APPLICATION OF THE GRAPEFRUIT JUICE DEMAND MODEL

Price Effect

FOB prices are adjusted to increase or reduce FOB movement in order to maintain inventories at desired levels. To investigate the benefits or costs of this price-manipulating practice to the industry, one has to consider the changes in FOB revenues that are caused by price changes.

The marginal effect of changes in FOB grapefruit juice price on FOB revenues can be estimated as[7]

$$(7)\quad \frac{\partial \hat{TR}_t}{\partial PW_t} = \frac{\partial MOVE_t}{\partial PW_t} \cdot \hat{PW}_t + \frac{\partial PW_t}{\partial PW_t} \cdot \hat{MOVE}_t$$

$$= \left(\frac{\partial MOVE_t}{\partial PW_t} + \frac{\partial MOVE_t}{\partial QR_t} \cdot \frac{\partial QR_t}{\partial PR_t} \cdot \frac{\partial PR_t}{\partial PW_t}\right) \cdot \hat{PW}_t + \hat{MOVE}_t$$

$$= .8992\hat{PW}_t + \hat{MOVE}_t$$

where $\hat{TR}$ is total revenue, i.e., the product of $\hat{MOVE}_t$ and $\hat{PW}_t$ and "^" represents estimate. Equation (7) states that any change in the FOB price would cause FOB movement, retail price, and retail demand to change. The change in total revenue with respect to a change in FOB price is a function of the FOB price and the FOB movement before price change. The total change in FOB revenue with respect to a given FOB price change can be estimated as

$$(8)\quad \Delta TR_t = \frac{\partial \hat{TR}_t}{\partial PW_t} \Delta PW_t = (-.8992\hat{PW}_t + \hat{MOVE}_t)\, \Delta PW_t$$

[7] The effect of a change in FOB price on retail price and retail demand internalized in the computation. Structural parameters were used in equation (7).

where "Δ" indicates changes. As shown in equation (8), when the ratio of $MOVE_t$ to PW_t is less than .8992, a decrease in FOB price (PW_t) would cause total revenue to increase. The change in total revenue becomes zero when the ratio equals .8992 and negative when the ratio is greater than .8992. The revenue gain resulting from price reduction is estimated by $(-.8992\hat{PW}_t)\Delta PW_t$, where ΔPW_t is negative, and the revenue loss because of lowered price is measured by $\hat{MOVE}_t \cdot \Delta\hat{PW}_t$. The sum of these two terms would be the net change in total revenue (ΔTR).

For example, if there were a 20-cent-per-SSE-gallon reduction in FOB price during the sample period (equivalent to 45 cents per dozen cans of 6-oz. frozen concentrates), and holding other exogenous variables constant, the price effect on FOB revenue is estimated by equation (8), and the results are shown in Table 7. The first column shows the cost of the price reduction to the industry, i.e., $\hat{MOVE}_t \cdot \Delta PW_t$, and the second column shows the change in total FOB revenue because of this price reduction, i.e., net revenue change.

TABLE 7. Estimated FOB Revenue Gains From FOB Price Reduction and Generic Advertising

Year	20-cent off FOB price		Advertising Expenditure	FOB Return from Advertising	
	MOVE*ΔPW (1)	ΔTR (2)	(3)	Historical (4)	20¢/gallon Increase (5)
	mil. $		$	mil. $	
71	18,881	39,769	898,718	8,788	49,254
72	20,775	30,575	1,079,060	12,765	53,758
73	22,065	27,927	2,958,464	23,323	49,718
74	21,398	24,141	1,359,602	14,868	58,691
75	22,760	25,073	838,708	11,226	60,085
76	24,540	19,065	1,677,784	18,584	56,057
77	24,540	19,904	1,522,385	19,193	61,524
78[a]	13,396	9,376	1,494,668	14,663	31,303

[a] First two quarters only.

The results indicate that it would have been profitable to have had FOB price reduction during the sample period. The highest revenue gains that could have been incurred with a price cut have deteriorated over time because of decreases in the value of the dollar,[8] and since the ratio of $MOVE_t$ to PW_t became larger after 1975.

Advertising Effect

Tables 3 through 6 show that generic advertising had positive effects on both FOB movements and FOB prices. The impact of generic advertising on FOB revenue can be estimated as

$$(9)\quad \Delta\hat{TR}_t = (MOVE_{t|ADV_t=x} - MOVE_{t|ADV_t=x'})\hat{PW}_t + (PW_{t|ADV_t=x} - PW_{t|ADV_t=x'})\hat{MOVE}_t$$

where $MOVE_t|_{ADV_t=x}$ represents the FOB movement, given generic advertising expenditures equal to x dollars in time period t. The same notation is used with PW. The first portion inside the parentheses on the right-hand side of equation (9) measures the increase in FOB movement that results from the effect of generic advertising. The second portion inside the parentheses measures the increase in FOB price that is the result of generic advertising. Equation (9) gives the total change in FOB revenue that follows a generic advertising change from x′ to x.

As shown in Tables 3 through 6, generic advertising had lagged effect on FOB movement and FOB price. Therefore, the total effect on FOB revenue of a given amount of generic advertising in time period t could be estimated as

$$(10)\quad \text{Total FOB revenue changes} = \sum_{i=0}^{3} [(MOVE_{t+i|ADV_t=x} - MOVE_{t+i|ADV_t=x'})\hat{PW}_{t+i} + (PW_{t+i|ADV_t=x} - PW_{t+i|ADV_t=x'})\hat{MOVE}_{t+i}]$$

The estimated total effect of generic advertising on FOB revenue for the sample period is presented in the column labeled "Historical" in Table 7. Note that, for all years, the estimated returns are higher than the generic advertising expenditures. For the period from January, 1970, through June, 1978, the FDOC spent $11.83 million for generic advertising of processed grapefruit in the U.S. During the same period, the net advertising profits at the FOB level were estimated to have totaled $123.41 million—an average net dollar return of $10.44 per dollar spent.

In the previous section, an example of a 20-cent-per-SSE-gallon reduction in FOB price was used to show the price effect on FOB revenue. Suppose that the cost of this price reduction (first column of Table 7) was used for generic advertising. Using equation (10), set x′ equal to the actual advertising level, and x to the sum of actual level and cost of price reduction, FOB revenue gains from such a strategy are shown in the last column of Table 7. In general, returns from the FOB price reduction would be smaller than those from generic advertising. This result would suggest more generic advertising; however, perhaps FOB price policies to promote the sales of Florida grapefruit juice should not be excluded from industry consideration, since this study has not explored interactions between price reduction and generic advertisements.

During the first quarter of 1978, advertising expenditures of $613,000 increased FOB revenues an estimated $2.58 million. The benefits

[8] With 1967 as the base period a 20-cent price reduction was worth 16.76 cents in the first quarter of 1971, and only 10.34 cents in the second quarter of 1978.

carry over into the second, third, and fourth quarters beyond the quarter of the actual expenditures. The FOB revenue increment was $1.71 million the second, $1.59 million the third, and $1.32 million the fourth quarter.

The estimates also indicate that significant positive benefits to advertising accrue for three quarters beyond the quarter during which the expenditure occurred. The solid line in Figure 2 illustrates the estimated impacts on FOB revenues for the first quarter of 1978 through the fourth quarter of 1978 resulting from the actual generic advertising expenditures in the first quarter of 1978. The carryover effect of the advertising expenditures in the first quarter of 1978 on FOB revenues is demonstrated by the dotted line.

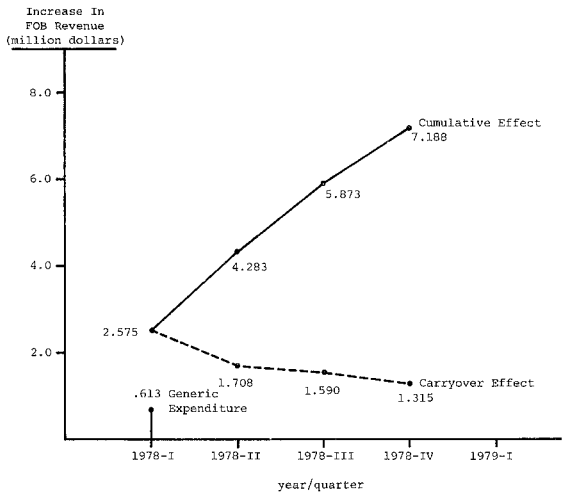

FIGURE 2. Estimated Generic Advertising Effect on FOB Revenue From Grapefruit Juice Advertisements of $613,000 During the First Quarter of 1978

CONCLUDING REMARKS

This study has focused primarily on the policies of the Florida grapefruit industry pertaining to price featuring and media advertising. The results suggest that, given the same costs to the industry, media advertising would be more profitable than would an FOB price reduction.

The optimum allocation[9] of given media advertising budgets estimated from long-range crop forecasts was not explored, as neither were the interactions among current media advertising expenditure and lagged advertising expenditures, and the relationship between FOB pricing and advertising expenditure.

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[9] Dorfman-Steiner static advertising theorem (Ward, 1975) cannot be applied here, because FOB price is considered as a function of advertising levels in this study.

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