AN EVALUATION OF MARKET ORDER GRADE CHANGES USING COVARIANCE ANALYSIS*

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Market orders authorized under both State and Federal legislation have long been employed to regulate the marketing of many agricultural products, especially fruits and vegetables. While their purposes vary and controls provided for differ, one provision that is common to a large number of orders allows the establishment of minimum standards of grade, maturity, or other characteristics of quality in the marketing of an agricultural commodity. These standards are usually set by the marketing order committee composed of producer and shipper members of the industry, subject to the approval of the Secretary of Agriculture.

Orders are instituted for the general purpose of allowing the development of more orderly marketing of the commodity. It is important for the industry to examine the impact of its market order program as the market environment in which it operates changes. For example, a change in regulations regarding grade standards requires an assessment to determine the expected impact and, thereby, provide guidelines to the decision makers.

This study was designed to evaluate the impact of a change in grade regulations concerning Texas grapefruit sold in the fresh market. Grapefruit produced in the Rio Grande Valley area of Texas have traditionally been marketed fresh in Southwest markets with some movement into the Midwest, Eastern, and Northwestern areas. Since 1960 the grades under which Texas fresh grapefruit could be shipped have been regulated by a Federal Market Order. This order establishes specifications for the grades shipped. In addition to U.S. No 1, U.S. No. 2, and U.S. No. 3 grades, a Combination grade was permitted consisting of a mixture of U.S. No. 1 and U.S. No. 2 grade grapefruit with a specified minimum percentage of U.S. No. 1.

While it was thought to be beneficial during short crop years to market a Combination grade, thus spreading the value of the No. 1 grade fruit, the changing marketing environment created by rapidly expanding production during the late 1960's suggested a different approach with regard to grade standards. Thus beginning with the 1968-69 season, the Combination grade was discontinued and all fresh grapefruit were marketed in conformance with specifications for U.S. No. 1, U.S. No. 2, and U.S. No. 3 grades. It was the purpose of this study to evaluate this change in permissable grading systems and determine its effect on retail sales of fresh Texas grapefruit.

METHODOLOGY

An analysis of the impact of a change in grade system on retail sales necessitates the consideration of a number of variables which may affect the purchase of the product by consumers. It was expected that product price at retail, shelf space allocation, income level of store clientele, and sales level of related products would be important. In theory, the influence of such variables can be dealt with through the use of an appropriately designed experiment. The practical considerations of running such an experiment in an actual market setting, however prevents their complete control. The procedure used here is a combination of an experimental design employed to control the influence of the primary variable, grade, and the use of an analysis of covariance model to "account for" the influence of the uncontrolled variables.

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Design and Data Collection

The experiment was designed to test retail sales responses to two different grade systems at the retail level. Two test markets were selected, each providing a different marketing environment. Dallas, Texas was selected as a market where Texas grapefruit has in the recent past composed much of the total supply of grapefruit (Table 1). Kansas City was selected as a test market in which Texas grapefruit has represented a relatively small share of the market.

Twelve stores were chosen in each market representing a cross-section of all income levels and geographic areas. Two grade systems were employed in supplying Texas grapefruit to the stores. Grade system I provided U.S. Combination grade grapefruit in bulk and U.S. No. 2 grade grapefruit in 20 pound sacks.[1] Grade system II provided U.S. No. 1 grade grapefruit in bulk and U.S. No.2 grapefruit in 20 pound sacks. The marketing of other grapefruit was continued without change for all stores.

A continuous eight-week period during late winter and early spring was divided into two four-week sub-periods. The twelve stores were divided into two equal groups matched on the basis of store size and income level of clientelein the neighborhood. The two grade systems were then assigned to the store groups and sub-periods with a rotation schedule set up such that each store was exposed to each system for a period of four weeks. The same pattern was employed in both market areas. Price was controlled only to the extent that during any given week the price of grapefruit was the same in all stores in a city regardless of grade system in the store.

Weekly records were kept of prices and shelf space allocation for all grapefruit items. Data were also collected weekly on volume sold by each store of all grapefruit items as well as other selected fresh fruit (apples, oranges, and bananas). The standard audit method of relating inventory change to deliveries and spoilage was used to derive sales.[2] The number of customer transactions for each store was also recorded on a weekly basis. This is a time series - cross section analysis due to the nature of the design covering both a number of stores and an eight week time period.

Table 1. UNLOADS OF FRESH GRAPEFRUIT FOR TWO SELECTED MARKETS, BY STATE OF ORIGIN, 1965-1969.*

Year	Dallas Market		Kansas City Market	
	Texas	Florida and other	Texas	Florida and other
	-percent-		-percent-	
1965	53.2	46.8	6.5	93.5
1966	74.8	25.2	23.8	76.2
1967	88.6	11.4	25.5	74.5
1968	77.4	22.6	20.1	79.9
1969	89.1	10.9	35.0	65.0
Average	78.6	21.4	23.2	76.8

*Source: U.S. Department of Agriculture [6].

[1] The Combination grade was comprised of a minimum of 60 percent U.S. No. 1 fruit and the rest U.S. No. 2.

[2] Sales = Beginning Inventory + Deliveries – Ending Inventory – Spoilage.

Covariance Model

The purpose of the covariance model used in this analysis was to examine the significance and magnitude of the impact of the grade change on the retail sales of grapefruit. The variable of key importance is the discrete variable used to represent grade while the other variables are incorporated to account for the influence of factors not controlled in the experimental design.

The basic general model may be represented as follows:

$$Y = a_o + a_1 D_1 + a_2 D_2 + b_1 X_1 \ldots + b_n X_n$$

where:

Y = pounds of grapefruit sold per customer transaction

$$D_1 = \begin{cases} 0 & \text{when observation represents grade system I (with Combination grade.)} \\ 1 & \text{when observation represents grade system II (with U.S. No. 1 grade.)} \end{cases}$$

$$D_2 = \begin{cases} 0 & \text{when observation represents grade system II (with U.S. No. 1 grade.)} \\ 1 & \text{when observation represents grade system I (with Combination grade.)} \end{cases}$$

$X_1 \ldots X$

$X_1 \ldots X_n$ = other independent variables; retail price, shelf space, sales level of selected competing products, and income level of store clientele (set of dummy variables).

The advantages and limitations of using such a model have been discussed extensively elsewhere [1, 3, 4, 5]. Since the use of the dummy variables introduces a problem of perfect intercorrelation among independent variables, a restriction must be introduced to avoid an indeterminate situation. In this case, the coefficient of D_2 was arbitrarily set equal to zero. This means that the estimated coefficient of D_1 represents the shift in intercept value associated with the introduction of U.S. No. 1 grade grapefruit in place of Combination grade.

It should also be noted that dummy variables to allow for slope changes for the other independent variables were not used, as the point of interest was the impact of grade change on sales. Additionally, it should be recognized that the sales volume of the other products were included in the equation as proxy variables to represent the effect of many factors related to each competitor (i.e. price and shelf space for each competitor.)

RESULTS

The eight-week experiment conducted in 12 stores yielded 96observations on each of the variables for each of the two market areas. Separate equations were estimated for each market to determine the difference in impact which the grade change may have had in relation to market area differences.

The dependent variable for the basic equations was termed "test grapefruit" in order to designate those grapefruit items which were actually involved in the grade change and were, depending on the store and period, either of U.S. No. 1 or Combination grade. This variable was measured in terms of pounds sold per customer. All sales volume figures for grapefruit and other products were deflated by appropriate customer transactions figures to remove sales variation related to differences in customer traffic through the stores.

Coefficients for grade, shelf space, oranges and bananas were found to be not significant at the 5 percent level in the initial equation estimated for Dallas.[3] Coefficients for apples, oranges and bananas were found to be not significant in the equation for Kansas City. Both equations were reestimated deleting all insignificant variables except the variable for grade in Dallas. This was retained as it is the variable of central interest in the analysis.

The coefficients for the two final equations are given in Table 2. Coefficients significant at least at the five percent level in the Dallas equation were those for price, income, and the sales volume of Florida grapefruit and apples. In the Kansas City equation price, shelf space, grade, income, and the sales volume of Florida grapefruit were significant at least at the same level.

While the signs of most coefficients are as expected, the positive sign for apples in the Dallas equation should be noted. A possible competitive relationship between apples and "test grapefruit" is not evident, whereas the competition between "test grapefruit" and Florida grapefruit is apparent. It is possible that the coefficient for apples reflects the effect of some other factor. A reasonable explanation for this may lie in merchandising differences among stores. Certain stores do a better job of merchandising produce than others, even within the same chain. In

[3] As usual, coefficients of continuous variables in the equations were examined for significance using a "t" test. An F test was employed to examine the significance of the coefficients of the dummy variables.

this case greater sales of both "test grapefruit" and apples might occur in the same store if the merchandising were superior, thus overshadowing any possible competitive relationship. In such a situation it would not be surprising to find a positive sign for this coefficient.

The coefficient of major importance in this analysis is that for grade. In the Dallas equation its magnitude is very small and was found not to be significant. In the Kansas City equation, however, the grade coefficient was found to be highly significant. This means that the grade variable is associated with a significant share of the variance in sales of "test grapefruit" per customer in the Kansas City equation. The addition of the dummy variable for grade results in a significantly reduced error sums of squares. From this it may be stated that sales per customer were significantly higher for U.S. No. 1 grade grapefruit relative to the Combination grade. The magnitude of the coefficient (0.0109 lbs.) when evaluated at the mean for per customer sales of Combination grade (0.0345 lbs.) indicates that sales per customer for U.S. No. 1 grade grapefruit were, on the average, 32 percent greater

From the industry standpoint it becomes important at this point to determine if the increase in bulk Texas grapefruit sales associated with the change to No. 1 grade grapefruit occurred at the expense of other Texas grapefruit in the market at the same time. The other item available was U.S. No. 2 grade grapefruit packaged in 20 pound mesh sacks. To test this, an equation was estimated using sales of this product on a per customer basis as the dependent variable. The results indicate that the dummy variable for grade change was not signicant in this equation; thus there was no significant change in the sales of U.S. No. 2 grapefruit associated with the grade change for Texas grapefruit sold in bulk.

It may be inferred from this that the increase in bulk Texas grapefruit sales should show up as an increase in total Texas grapefruit sales. Again an equation was estimated using total sales of Texas grapefruit per customer as the dependent variable. The anticipated relationship was verified as the coefficient for grade had a positive sign and was significant at the 10 percent level.

Table 2. COEFFICIENTS FOR LINEAR REGRESSION EQUATIONS FOR "TEST GRAPEFRUIT" BY CITY.

Variable	Regression Coefficients[a]	
	Dallas Equation[b]	Kansas City Equation[c]
Intercept Value (lbs./customer)	0.0858	0.0795
Price (cents/lb.)	-0.0057* (0.0027)	-0.0061* (0.0020)
Shelf Space (square feet)		0.0022* (0.0006)
Grade	0.0014 (0.0083)	0.0109* (0.0040)
Income[d] (high)	0.0159 (0.0105) *	0.0178 (0.0054) *
Income[d] (low)	-0.0228 (0.0116)	0.0006 (0.0048)
Sales of Apples (lbs./customer)	0.3387* (0.0655)	
Sales of Florida Grapefruit (lbs./customer)	-1.4866* (0.5108)	-0.1039* (0.0422)

*Coefficient significant at .05 level. An F test was used to test significance of coefficients for dummy variables; a t test for the others.

[a]Standard errors are given in parentheses under coefficients.

[b]$R^2 = .52$

[c]$R^2 = .36$

[d]Income level was incorporated by using a set of three dummy variables. The medium level was deleted to avoid singularity.

CONCLUSIONS AND IMPLICATIONS

Of key importance in evaluating these results is the relationship between the impact of the grade change and the nature of the specific market environment. It was observed that the change in grade system had a significant effect on per customer sales of grapefruit in the test stores in the Kansas City market. At the same time, no significant response to the same change was observed in Dallas. The most evident difference in the nature of the two markets, with respect to fresh grapefruit, lies in the fact that Dallas has long been dominantly supplied with Florida grapefruit (Table 1). Fresh market grapefruit shipped out of Florida has been required to meet U.S. No. 1 standards for many years whereas, much of the Texas grapefruit shipped prior to the 1968-69 season was of Combination or U.S. No. 2 grade.

The results of this study suggest that the impact of the grade change to U.S. No. 1 was related to the market environment as characterized by the degree of competition from other grapefruit supply areas. In a market where strong competition exists from supply areas with established standards of quality, the sales of Texas grapefruit can be significantly enhanced by supplying a U.S. No. 1 grade instead of a Combination grade. In a market where Texas grapefruit has long been accepted and no effective competition from other supply areas has existed, the sales are not affected measurably by the grade change in the short run.

The major implication to the decision-makers of the Texas industry becomes apparent when the rapidly expanding Texas grapefruit production is considered [2; p. 18]. The citrus industry in Texas has recovered from the short supply situation of the early 1960's. It is moving toward a situation where the existence of a large supply of grapefruit will require that new markets be carved out in areas that in recent years have not been users of Texas citrus. Strong preferences and supplier arrangements have developed for grapefruit from other areas. It is suggested by the results of this study that development of these new markets will be facilitated by the change from shipment of Combination grade to the shipment of U.S. No. 1 grade grapefruit.

The dynamic nature of market environments and characteristics of supply require a continuing program of evaluation on the part of market order committees. Research such as discussed in this paper must be subject to verification in different ways, under other circumstances, through follow-up research programs, examination of aggregate industry data, and even repetition of the experiment if conditions have changed significantly. Continuing efforts to improve the ability of market orders to effect more orderly marketing of agricultural products must be made. For an agricultural industry, organized under a marketing order, to take maximum advantage of new opportunities, its programs must be flexible, responsive, and subject to continuing review.

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