AN ECONOMETRIC ANALYSIS OF THE FLORIDA GRAPEFRUIT INDUSTRY

By

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A Dissertation Presented to the Graduate Council
of the University of Florida
in Partial Fulfillment of the Requirements for the
Degree of Doctor of Philosophy

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Arthur F. Parker, Jr.

March, 1973

Chairman: Dr. W. W. McPherson
Co-chairman: Dr. L. H. Myers
Major Department: Food and Resource Economics

The objectives of this study were (1) to quantitatively describe, by means of a simultaneous equation model, the Florida grapefruit industry from the grower transactions at harvest to the FOB level for canned single-strength juice, canned sections, frozen concentrated juice and fresh grapefruit, (2) to measure the effects of factors exogenous to the Florida grapefruit industry on the production and sale of the four products listed above, and (3) to develop a model for forecasting values of the variables endogenous to the Florida grapefruit industry.

Two models were developed: one for the months in which fruit was harvested and thus available for processing and for fresh pack (Model I) and one for the months when no fruit was available (Model II). Model I consisted of 11 behavioral equations and seven identities for the crop years

1964-65 to 1970-71. Model II consisted of six behavioral equations and six identities for the crop years 1963-64 to 1969-70. Included in Model I were behavioral relationships for (1) on-tree prices for grapefruit for packing and for processing, (2) pack for each of canned sections and frozen concentrated juice, (3) storage of each of the processed products, and (4) FOB demand for each of the processed products, as well as FOB demand for fresh grapefruit. The behavioral relationships for Model II included (1) storage of each of the processed products and (2) FOB demand for each of the processed products. The behavioral equations were estimated by means of two-stage least squares. Monthly data were used.

The supply of fruit to packers and processors was assumed to be predetermined. In the processor and packer on-tree price equations, both the quantity available and the prices of the products to be derived from the fruit were shown to affect on-tree prices. For fresh fruit, the margin between the on-tree price and the FOB price was found to increase with advances in the price level.

The pack and storage equations contained price expectation relationships. The results indicated that current prices had more influence on pack and storage than did expected prices.

The FOB demand equations were each estimated with the quantity of a product demanded as a function of its FOB price, the prices of substitutes, disposable personal income per capita, the FOB quantity in the previous month and the month. In general, seasonality in demand was found to exist, the income effects were positive and the own-price slopes were negative.

Average values were used to calculate elasticities. For Model I, price elasticities of demand at the FOB level were -0.392 for single-strength juice, -2.101 for canned sections, 0.163 for frozen concentrated juice and -12.268 for fresh grapefruit. For Model II, the elasticities for the first three products above were -1.254, -2.636 and -2.096, respectively. For both Model I and Model II, cross elasticities indicated that single-strength juice and frozen concentrated juice were substitutes.

Direct and derived reduced form estimates were obtained for the two models. Implications of the derived reduced forms were discussed.

Finally, predictions were obtained for each model using both the direct and derived reduced form estimates. Predictions were made for December, 1971, to March, 1972, for Model I and for August and September, 1971, for Model II. Model I predictions were evaluated using Theil's inequality coefficients. Because there were only two data points, Model II predictions were not evaluated. The predictions for Model II appeared to be considerably more accurate than were those for Model I.

CHAPTER I

INTRODUCTION

During the past decade, Florida growers have produced approximately 76 percent of the grapefruit produced in the United States. The amount produced annually has varied from 26 to 44 million boxes, with an annual average of over 34 million boxes. California, Texas and Arizona produce average annual quantities of 4.1, 3.9 and 2.7 million boxes, respectively, and are the only other states that produce grapefruit. In terms of total value of farm production in Florida, grapefruit ranks third, among different commodities, behind oranges and tomatoes, with an annual average farm value of over 44 million dollars. During the 1970-71 season the value of the production of oranges, the primary agricultural commodity in the state, was approximately 189 million dollars [19, 1971 issue,p. 18].

Varieties of Florida grapefruit are classified, based on physical characteristics, into white seedy, white seedless and pink seedless grapefruit. The white seedless type is primarily composed of the Marsh variety. The Duncan variety is the predominant white seedy type. In December, 1969, 26.8 percent of the bearing acreage was of the pink seedless type, 47.8 percent was of the white seedless type and the other 25.4 percent was white seedy [20]. The harvest of each type usually begins in September, but it is October before any appreciable quantity is available for market. Harvest of the seedy type peaks in October, tapers off through the succeeding months and ends in April or May. The white seedless type is available in large quantities in October; thereafter the production decreases for a month or two and then increases. In February or March, production peaks and then tapers off until June or July, at which time picking ceases. The seasonal production pattern for pink seedless fruit is similar to that for the white seedless type.

The fact that these patterns exist tends to complicate the decision-making process for processors and packers. For example, except for a very few products, pink grapefruit is not desirable for processing because of the color that it imparts to the products. On the other hand, the Duncan variety is preferred for use in canned grapefruit sections because of its fairly large sections. The matter of storage of processed products also enters the decision-making process, as there is no fresh fruit available during the summer months.

Florida grapefruit production may also be categorized with respect to geographic location. Grapefruit is generally produced in the lower two-thirds of the state, from

Putnam, Flagler and Marion counties south to Collier and Broward counties (Fig. 1). The two general areas are referred to as the Indian River district and the Interior district [22, p. 40]. During the crop years 1966-67 through 1970-71, 27.8 percent of the grapefruit produced in Florida was produced in the Indian River district, while the other seedless 72.2 percent was produced in the Interior district. seedy .

Efforts to establish a differentiation between Indian River and Interior grapefruit have been highly successful. For years, Indian River packers have advertised fresh Indian River fruit as being of a higher quality than fruit from the other region. This campaign was successful, as shown by the fact that, for the past five years, grapefruit from the Indian River district has commanded an on-tree price averaging over 75 cents per box more than Interior district prices. However, it has been shown that product differentiation has decreased in the last year or two [24, p. ii]. Prices of grapefruit for processing in the two districts have tended to be about equal.

The grapefruit industry is organized along the following lines. The growers sell the grapefruit either to packers, for sale later as fresh fruit, or to processors for processing into 10 processed grapefruit products. There are at present approximately 34 firms that process citrus. Most of these firms produce at least some of the products derived from grapefruit. Some firms produce only single-strength

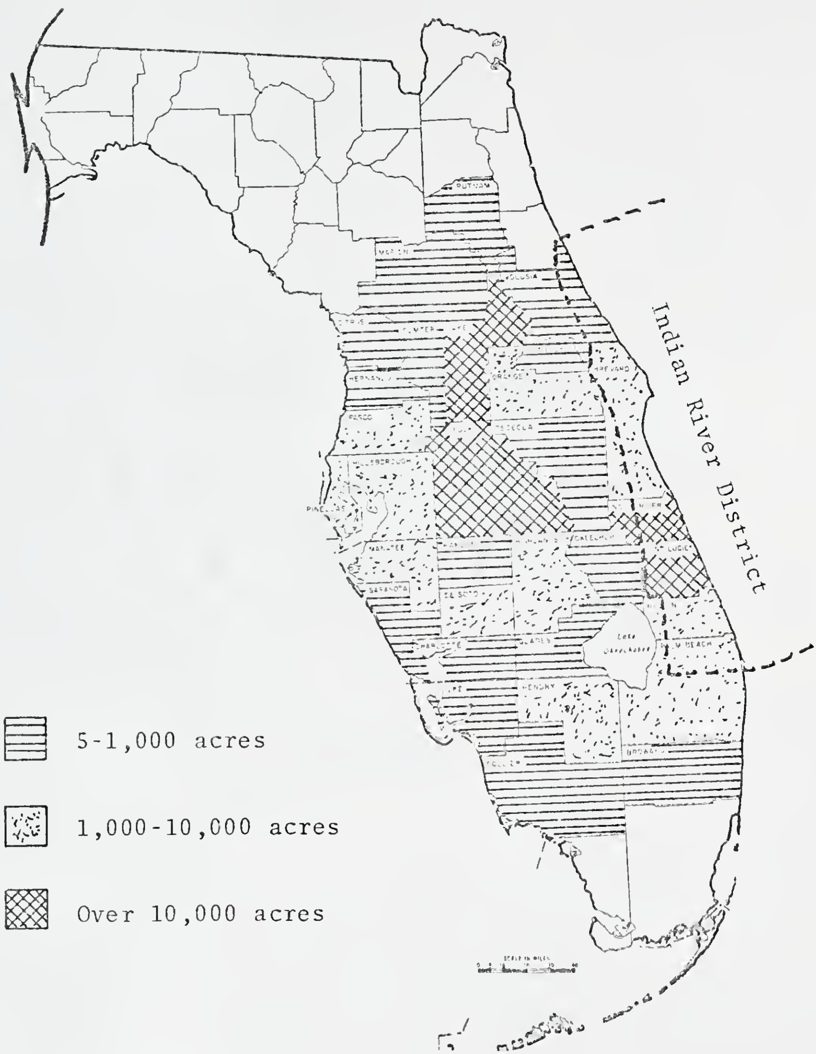

Figure 1. Distribution of commercial grapefruit acreage, by counties, as of December, 1969, and delineation of Indian River district.

juices; othersproduce almost all of the products except canned sections. During 1970-71, approximately 120 to 130 firms packed fresh grapefruit. The number has varied from year to year as a number of the smaller firms have ceased packing operations or merged with larger firms. Also, small firms are continually being formed. During the crop years 1967-68 to 1970-71, approximately 38.3 percent of the grapefruit crop was delivered to the packers, with the rest going to the processors. The products that are derived from grapefruit, as well as the relative importance of each, are shown in Table 1. Processors pack the 10 processed products and move them into the warehouse to be sold at a later date or they sell them immediately to buyers (i.e., chain stores and wholesalers). During the months when grapefruit is available for processing, processors build up inventories for the summer months when fresh fruit is not available. During the months of no grapefruit production, processed products are moved from the warehouse and into the marketing channels for final consumption.

Fresh grapefruit, canned juice, canned sections and frozen concentrated juice, which account annually for about 89 percent of the total crop, were included in this study. The other seven products account for the other 11 percent; the most important of the seven, chilled juice, accounted for an average of less than 5 percent over the four years included in Table 1. Although chilled juice is a relatively

Table 1. Percent of the Grapefruit Crop Accounted for by Each Product Form, 1967-68 Through 1970-71 Seasons

Product Form	Percent of Total Grapefruit Crop			
	1970-71	1969-70	1968-69	1967-68
Fresh	34.8	38.0	35.2	45.0
Canned Juice	34.0	32.8	29.7	30.2
Frozen Concentrate	15.7	12.1	16.5	5.4
Chilled Juice	5.5	4.9	4.1	3.9
Canned Sections	5.4	6.6	7.6	7.9
Canned Blend	1.6	2.0	2.1	2.1
Chilled Salad	1.5	1.9	2.7	3.9
Chilled Sections	1.1	1.2	1.5	1.0
Canned Salad	0.2	0.4	0.5	0.6
Processed Concentrate	0.2	0.1	0.1	0.0
Frozen Blend	*	*	*	*
TOTAL	100.0	100.0	100.0	100.0

*Less than .1 percent.

Source: Florida Citrus Mutual, Annual Statistical Report, Lakeland, Florida, 1970-71 issue.

new product, it is currently more important than canned sections. However, a lack of data for the earlier years included in the study precluded its use in this analysis. The other processed products, as a group, represent such a small proportion of the total that they were omitted in this study.

There are three main types of arrangements for the sale of fruit to packers and processors. Cash buyers deal directly with growers and an agreement is reached as to price and quantity to be exchanged. The participation plan type of contract is a hedge against a loss of markets resulting from an oversupply of fruit. Most plans contain provisions whereby a grower binds all or a portion of his fruit to a processor. The price of the fruit is determined at the end of the pool period and is based upon a formula specified in the contract. Generally, the pool periods end either at the end of the crop year or approximately midway through it, depending on the contract. Thus, the processor pays the grower at the end of the year only for the fruit used, based on the price that the processor receives for the processed products derived from the fruit. This type of arrangement is advantageous to growers in that they are assured of a market for all or part of their fruit. The processor benefits in that he is assured of both a source of supply and a locked-in profit margin. The third type of arrangement is the cooperative. Member growers pool their fruit and sell it as a group rather than individually. At the end of the operating year, profit received by the cooperative from the sale of products derived from the fruit, including byproducts, is divided among the members in proportion to the quantity each member put into the pool. In some cases, cooperatives have started their own processing plants. They benefit from an assured market, even though the fruit is unpriced until the end of the year. Also, members share in the profits of the cooperative's processing plants. Similarly, packers and processors that deal with the cooperative are fairly certain of a source of raw fruit.

Each of the three arrangements has a different effect on the allocation of the fruit to be packed or processed. The participation plan member has no choice as to how his fruit is allocated; that is, price does not play a role in the decision to supply the fruit to a packer or to a processor. The same is true for the cooperative member. Only the cash seller has this option. During the 1970-71 season, almost 28 million boxes of grapefruit were utilized by processors for the production of various processed grapefruit products. Of this total, nearly 10 million boxes, or almost 35 percent, were moved to the processors as priced fruit [4].

The Florida grapefruit industry is constantly faced with the possibility of widely fluctuating supplies of fruit combined with a more or less steadily increasing demand for grapefruit products. This condition results in substantial year-to-year variations in prices and net revenues to growers. Unlike industrial production, where the flow of raw materials can be adjusted as conditions require, the supply of grapefruit is a rather long-term proposition. Trees will produce fruit for many years, so that short-run variations in supplies are primarily the result of weather and basically beyond the control of producers.

Growers, then, as well as packers and processors, are faced with constraints on the volume of fruit available at a particular point in time within the season as well as that for the total season. Both of these constraints make utilization and marketing decisions more difficult. The more information that is available to decision makers, the better the industry can adjust to the factors over which it has no control.

Objectives

Necessary inputs into the decision-making process include empirical estimates of the supply and demand relationships at each transaction point in the system. Also needed are estimates of economic relationships, such as price-quantity relationships and the effects of inventory levels, which determine the allocation of grapefruit among various products and between storage and current sales.

The objectives of this study follow:

(1) To quantitatively describe, by means of an econometric model, the Florida grapefruit industry from the grower transactions at harvest to the FOB level for canned single-strength juice, canned sections, frozen concentrated juice and fresh grapefruit.

(2) To measure the effects of factors exogenous to the Florida grapefruit industry on the production and sale of the four products included in the study.

(3) To develop a model for forecasting values of the variables endogenous to the Florida grapefruit industry.

Literature Review

Research dealing with the Florida citrus subsector has dealt primarily with the orange industry. The grapefruit industry was included only when it was necessary for the quantification of economic relationships dealing with orange products, such as substitutes in demand equations. This emphasis on oranges has possibly been due to the fact that the orange industry has historically been of much greater economic importance than has the grapefruit industry.

Shafer has conducted several studies relating to the annual demand for Texas grapefruit. Estimates of the demand for Florida grapefruit were obtained as a byproduct of his studies. In An Analysis of Season Average Prices for Texas Grapefruit, 1949-1967 [14], Shafer and Gutierrez analyzed grapefruit prices for the years from 1949 to 1967. They found that the Florida crop values generally tended to move inversely with the size of the Florida crop. A 1 percent change in Florida production on a U. S. per capita basis was associated with a 1.68 percent change of opposite sign in the Florida price for fresh grapefruit. In the case of grapefruit for processing, a 1 percent change in production per capita was found to be associated with a 2.3 percent change in price in the opposite direction.

A later study by Shafer [13] updated the previous study. It was found that the quantity of Florida production allocated to fresh use exerted a significant negative effect on the season average FOB price for Texas grapefruit. From this information, it was concluded that fresh Florida grapefruit and fresh Texas grapefruit were substitutes for one another.

In a study by Ward [25], detailed price-quantity relationships were estimated for grapefruit from the Indian River district. In particular, it was found that over one-third of the weekly variation in the FOB price of Indian River grapefruit was explained by weekly changes in shipments from Indian River, Interior Florida and Texas. Further, Texas shipments were found to have a greater influence on the Indian River price than did Interior shipments.

Another study by Ward [24], conducted a year later, generally confirmed the results of the previous study. He found, however, that Indian River grapefruit prices had become more responsive to Interior Florida and Texas shipments, with the increased price responsiveness to Texas shipments far exceeding the response to Interior shipments.

A study with objectives similar to those of the present study was conducted by Vanderborre [23] for the soybean economy. He described the markets for soybean oil and soybean meal by means of a simultaneous equation model. A primary objective of that study was the estimation of the demand relationships for both domestic and export markets for soybean products. The model consisted of equations for the wholesale demands for crude soybean oil and for soybean meal, as well as equations for the export demand for these two commodities. Pricing, margin and stock equations were also included. First differences were used in all of the equations in an effort to reduce the possibility of autocorrelation and multicollinearity. Conclusions were reached with respect to the effects of the exogenous variables on the endogenous variables by algebraic manipulation of the structural equations which were estimated by means of two-stage least squares. At the time of the publication of the article, the model had not yet been tested for its predictive ability.

Kulshreshtha and Wilson [9] presented a simultaneous equation model of the Canadian beef cattle industry as a first attempt to examine the interdependent nature of demand, supply and price relationships in that industry. The complete system included six behavioral equations and three identities. Behavioral equations were estimated by means of two-stage least squares and included relationships for the demand for beef, the demand for live cattle for export, retail prices, slaughter, dressed weight and inventory. One of the major purposes of the study was to derive a model for predicting changes in the beef cattle sector. For predictions, the authors converted the structural equations and the identities into reduced form equations. The predictive ability of the model was evaluated with Theil's U-coefficient [16, p. 28, and 17, p. 32].

Another study with objectives and methodology similar to the present one was conducted by Myers, Havlicek and Henderson [11]. The objective was to obtain a simultaneous equation model of the monthly structure of the hog-pork sector of the United States. The model consisted of eight behavioral equations and two identities. The behavioral equations represented the supply and demand relationships, as well as margin equations, that existed within the hog-pork sector from the farm level to the retail level. Two-stage least squares was used to estimate the parameters of the model. Then, using the second-stage structural equations and the first-stage reduced form equations, values of the endogenous variables were predicted for 18 months for which the data had not been used in the original estimates. The ability of the model to predict was evaluated by several means. As in the previously mentioned study, Theil's

U-coefficient was calculated for each endogenous variable. Also, the predictive ability of the model was evaluated by means of its ability to predict changes in direction in the endogenous variables.

Organization of Presentation

The economic model of the Florida grapefruit industry is described in the second chapter. The third chapter contains the statistical model, as well as a discussion of the statistical procedures used. The statistical results of the study are presented in the fourth chapter. The fifth chapter consists of implications drawn from the results of the statistical analysis, including elasticity estimates and a prediction model. In the final chapter the results and conclusions are summarized.

CHAPTER II

MODEL DEVELOPMENT

At each level of exchange of fruit or processed product, there are relationships that interact to determine price and quantity. In addition, each level affects each other level in that changes in prices and quantities at one level cause repercussions in other levels. For example, a change in the FOB price of a product affects pack decisions of that product, which in turn affects the pack of the other products. Hence, the system was formulated as a simultaneous one.

There are several months of each year when all four products included in this study are produced. Model I represents these months. However, grapefruit is not picked year round, nor can it be stored in fresh form for very long. Model II represents the months when there is no harvest. Finally, there are months during which some, but not all, of the products are produced. These months were distributed between the two models according to the following criteria. If canned single-strength grapefruit juice, which normally accounts for approximately 55 percent of all processed grapefruit, was produced during a month, that month was placed in Model I. Fresh pack usually coincides with the months during which single-strength juice is produced.

On this basis, Model I included the nine months from October to June, while Model II included July, August and September.

Retail prices were deflated by the consumer price index, while all other prices were deflated by the wholesale price index for farm products. Also, all quantities, after the raw fruit was supplied to the packers and to the processors, were converted to the equivalent of gallons of single-strength juice. This conversion was made to facilitate direct comparisons among products.

Model I

Price of Grapefruit for Packing

The quantity of grapefruit that growers are willing to supply to packers was assumed to be determined outside of the system. Rather than supply being a function of economic variables, it is a function of the month of the season, with a constant quantity being supplied in a particular month. For example, it was found that the average quantities going to fresh use, during the years included in this study, in December, January, February and March were 1.555, 1.757, 1.650 and 2.102 million boxes, respectively. The corresponding standard deviations were 0.172, 0.143, 0.161 and 0.280, respectively. Thus, an economic supply function was not specified for the system. The same reasoning was applied for the quantity of grapefruit supplied for processing.

When the supply of fruit is predetermined, price becomes the critical variable for equating supply with demand. Therefore, the equation was formulated with on-tree price as an endogenous variable and quantities supplied as a predetermined explanatory variable. Since the packers purchase the fruit to pack and then sell at the FOB level, the FOB price was also hypothesized as influencing on-tree prices. The relationship is shown below.

$$(2\text{-}1) \quad PGK_{ms} = f(PFFG_{ms}, GK_{ms})$$

where PGK_{ms} = deflated on-tree price of grapefruit for fresh packing in month m and year s (dollars per 1 3/5-bushel box).

$PFFG_{ms}$ = deflated FOB price of fresh grapefruit in month m and year s (dollars per 1 3/5-bushel box).

GK_{ms} = quantity of grapefruit for packing in month m and year s (million 1 3/5-bushel boxes).

It was expected that the FOB price and the on-tree price would change in the same direction. Also, since supply was predetermined, the price was expected to fluctuate inversely with the quantity of fruit available in a particular month. Therefore, $\partial PGK_{ms}/\partial GK_{ms} < 0$.

Price of Grapefruit for Processing

The equation for the price of grapefruit for processing was similar to that for packing in that it was derived from the FOB level. The price that the processors pay for the fruit was expressed as a function of, among other things, the quantity of fruit going to the processors. Because of the various contractual arrangements within the industry whereby the price growers receive is determined by the FOB prices received for the output and the processing cost, the on-tree price was also a function of the FOB prices of the three processed products and the average cost of processing.

The year was used in other equations in the model. Both the year and processing costs were exogenous variables. Since the system was formulated as a simultaneous one, no predetermined variables should be highly correlated. To violate this principle could result in a singular matrix of exogenous variables. The correlation coefficient between the year and processing costs was found to be 0.91. Because of this close relationship, the year was used in place of processing costs.

The equation for the price is given below.

$$(2\text{-}2)\quad PGR_{ms} = f(PFCS_{ms}, PFCG_{ms}, PFFC_{ms}, GR_{ms}, s)$$

where PGR_{ms} = deflated on-tree price of grapefruit for processing in month m and year s (dollars per 1 3/5-bushel box).

$PFCS_{ms}$ = deflated FOB price of canned single-strength grapefruit juice in month m and year s (dollars per case of twelve 46-ounce cans).

$PFCG_{ms}$ = deflated FOB price of canned grapefruit sections in month m and year s (dollars per case of 24 number 303 cans).

$PFFC_{ms}$ = deflated FOB price of frozen concentrated grapefruit juice in month m and year s (dollars per case of twelve 6-ounce cans).

GR_{ms} = quantity of grapefruit for processing in month m and year s (million 1 3/5-bushel boxes).

s = harvest season (1964-65 season = 1).

Utilization or Pack

After processors have purchased the fruit, a decision must be made with regard to allocating the fruit among alternative products. Products produced will be either sold to buyers immediately or stored for later sale. Thus, the quantity packed was expected to be a function of both the current FOB price of the product (in the event that the product is sold during the current time period) and the expected FOB price of the product (in the event that it is stored for later sale). The expected price is the current expectation of the price that the processor feels he will receive if he sells his current output at a later date. Since the fruit can be used in the production of more than one product, FOB prices of alternative products were considered. Further, the quantity of product currently in storage must be considered. It was expected that producers desire to reduce the pack of a particular product when inventories exceed certain levels. It was anticipated that the increased popularity of frozen food products during the years included in the study had resulted in an increase in the production of frozen concentrated grapefruit juice. It was also expected that the production patterns of the other two processed products had been altered over time. To measure these effects, time, as measured by numbering the marketing seasons, was included as an independent variable in the relationships.

As discussed in Chapter I, some varieties of grapefruit are better suited for use in certain processed products, while other varieties are best suited to other products. Since different varieties mature during different months of the season, the pack of a product depends somewhat upon the month of the year. Finally, in making production decisions, the best public information available as to crop size is the United States Department of Agriculture (USDA) crop estimate. The pack relationships for canned sections and frozen concentrated juice are shown below. The equation for canned single-strength juice is discussed subsequently in this section.

$$(2\text{-}3) \quad PCG_{ms} = f(PFCS_{ms}, PFCS^*_{ms}, PFCG_{ms}, PFCG^*_{ms}, PFFC_{ms}, PFFC^*_{ms}, BCG_{ms}, s, m, m^2, GE_{ms})$$

$$(2\text{-}4) \quad PFC_{ms} = f(PFCS_{ms}, PFCS^*_{ms}, PFCG_{ms}, PFCG^*_{ms}, PFFC_{ms}, PFFC^*_{ms}, BFC_{ms}, s, m, m^2, GE_{ms})$$

where PCG_{ms} = quantity of canned grapefruit sections produced during month m in year s (million gallons single-strength).

PFC_{ms} = quantity of frozen concentrated grapefruit juice produced during month m in year s (million gallons single-strength).

$PFCS^*_{ms}$ = the expectation, during month m in year s, of the FOB price that will be received for canned single-strength grapefruit juice sold at a later date (dollars per case of twelve 46-ounce cans).

$PFCG^*_{ms}$ = the expectation, during month m in year s, of the FOB price that will be received for canned grapefruit sections sold at a later date (dollars per case of 24 number 303 cans).

$PFFC^*_{ms}$ = the expectation, during month m in year s, of the FOB price that will be received for frozen concentrated grapefruit juice sold at a later date (dollars per case of twelve 6-ounce cans).

BCG_{ms} = inventory of canned grapefruit sections at beginning of month m in year s (million gallons single-strength).

BFC_{ms} = inventory of frozen concentrated grapefruit juice at beginning of month m in year s (million gallons single-strength).

GE_{ms} = official USDA estimate, during month m in year s, of the size of the grapefruit crop for year s (million 1 3/5-bushel boxes).

The other variables have been defined previously.

Since producers are assumed to be profit maximizers, it was expected that they react to increased current and expected prices by attempting to increase output, thus it was expected that $\partial PCG_{ms}/\partial PFCG_{ms}$ and $\partial PCG_{ms}/\partial PFCG^*_{ms}$ would be > 0. Since the three processed products are viewed by the industry as alternatives, it was anticipated that an increase in either the current or expected FOB price of one of the alternative products results in a shift of productive resources to the product with the higher price. Therefore, it was expected, a priori, that $\partial PCG_{ms}/\partial PFCS_{ms}$, $\partial PCG_{ms}/\partial PFCS^*_{ms}$, $\partial PCG_{ms}/\partial PFFC_{ms}$ and $\partial PCG_{ms}/\partial PFFC^*_{ms} < 0$. The reasoning behind

$\partial PCG_{ms}/\partial BCG_{ms} < 0$ was explained above. Because of the pattern of production whereby the quantity produced increases one or more months and then decreases, it was expected that $\partial PCG_{ms}/\partial m > 0$ and $\partial PCG_{ms}/\partial m^2 < 0$. Finally, it was expected that the annual size of the crop and the production of each of the products would be directly related. The foregoing discussion involved primarily relationship (2-3), but the relationships in (2-4) were expected to be similar to those in (2-3).

Over the past several years, the quantity of canned sections produced annually has decreased, while the production of frozen concentrated juice has increased. This gave rise to the expectation of $\partial PCG_{ms}/\partial s < 0$ and $\partial PFC_{ms}/\partial s > 0$.

Expected prices appear in the above relationships. However, it is difficult, if not impossible, to obtain data relating to price expectations. The expected FOB price of a product is the expectation, in time period ms, of the average FOB price for that product expected for the remainder of the year beyond time period ms and as such is a reflection of the expected future supply and demand conditions for that product. Future supply expectations are based on the current crop estimate for that year. Demand expectations are based on the current FOB price of the product. Since FOB prices do not vary widely over the course of a crop year, the current price should reflect fairly accurately the expected FOB price. The price expectation relationships are given below.

$$(2\text{-}5)\quad PFCS^*_{ms} = g_1(PFCS_{ms}, GE_{ms})$$

$$(2\text{-}6)\quad PFCG^*_{ms} = g_2(PFCG_{ms}, GE_{ms})$$

$$(2\text{-}7)\quad PFFC^*_{ms} = g_3(PFFC_{ms}, GE_{ms})$$

These variables were defined previously.

Since GE_{ms} was included in relationship (2-5) to reflect future supply expectations, it was expected that $\partial PFCS^*_{ms}/\partial GE_{ms} < 0$ because a larger supply in the future would generally lead to lower future prices. $PFCS_{ms}$ was included to reflect demand expectations, so $\partial PFCS^*_{ms}/\partial PFCS_{ms} > 0$. Similar relationships were expected for (2-6) and (2-7).

When the expected price relationships were substituted into that for the pack of canned sections, the following equation was obtained.

$$(2\text{-}8)\quad PCG_{ms} = f[PFCS_{ms}, g_1(PFCS_{ms}, GE_{ms}), PFCG_{ms}, g_2(PFCG_{ms}, GE_{ms}), PFFC_{ms}, g_3(PFFC_{ms}, GE_{ms}), BCG_{ms}, s, m, m^2, GE_{ms}]$$

or

$$(2\text{-}9)\quad PCG_{ms} = h(PFCS_{ms}, PFCG_{ms}, PFFC_{ms}, GE_{ms}, BCG_{ms}, s, m, m^2)$$

From (2-8) it can be seen that $PFCG_{ms}$ has an effect both directly and indirectly through $PFCG^*_{ms}$. To determine a priori what effect the combination will have on the quantity packed, it was necessary to examine the effects separately and then put them together. The effect through the expected price was

$$\frac{\partial PCG_{ms}}{\partial PFCG^*_{ms}} \cdot \frac{\partial PFCG^*_{ms}}{\partial PFCG_{ms}} > 0 \text{ or } \frac{\partial PCG_{ms}}{\partial PFCG_{ms}} > 0$$

as both partial derivatives are positive. When the direct effect, which has a positive partial derivative, is added to the above, the total effect is > 0. The other variables were analyzed in a similar manner to determine if the relationship (i.e., whether direct or inverse) had changed with the introduction of the expected price. It was found that, with the exception of the crop estimate, all sign expectations were unchanged from those discussed earlier.

In the case of GE_{ms}, the combined effect of the estimate directly and through each of the three expected prices could not be determined a priori. Again, this relationship can be derived from (2-8) above. The total effect, composed of the sum of four parts, is

$$\frac{\partial PCG_{ms}}{\partial PFCS^*_{ms}} \cdot \frac{\partial PFCS^*_{ms}}{\partial GE_{ms}} + \frac{\partial PCG_{ms}}{\partial PFCG^*_{ms}} \cdot \frac{\partial PFCG^*_{ms}}{\partial GE_{ms}} + \frac{\partial PCG_{ms}}{\partial PFFC^*_{ms}} \cdot \frac{\partial PFFC^*_{ms}}{\partial GE_{ms}} + \frac{\partial PCG_{ms}}{\partial GE_{ms}} \gtrless 0$$

The first effect is negative, while the other three are positive. Thus, the total effect depends upon the relative magnitudes of the partial derivatives. The relationships for the pack of frozen concentrated juice were analyzed in an analogous manner and yielded essentially similar results.

Since the total quantity of grapefruit purchased for processing is predetermined, it is possible to determine the pack of canned single-strength juice if the pack of the other two processed products is known. Since the fruit cannot be stored very long after it is picked, it is reasonable to assume that the sum of the quantities of the three products that are produced is equal to the quantity of fruit purchased for processing. Because GR_{ms} is given in boxes and quantities packed are given in gallons single-strength, it was necessary to convert pack to boxes. This was done by dividing the pack of each product by the average yield of grapefruit used for that product times the number of gallons per case (3.375 for single-strength juice and canned sections and 4.0 for frozen concentrated juice). Hence

$$(2\text{-}10)\quad GR_{ms} = \frac{PCS_{ms}}{\overline{Y}CS\cdot 3.375} + \frac{PCG_{ms}}{\overline{Y}CG\cdot 3.375} + \frac{PFC_{ms}}{\overline{Y}FC\cdot 4.0}$$

or

$$(2\text{-}11)\quad GR_{ms} = \frac{PCS_{ms}}{4.54410} + \frac{PCG_{ms}}{4.01547} + \frac{PFC_{ms}}{4.02932}$$

where PCS_{ms} = quantity of canned single-strength grapefruit juice produced during month m in year s (million gallons).

$\overline{Y}CS$ = average yield of canned single-strength grapefruit juice (cases of number 2 cans per box of fruit).

$\overline{Y}CG$ = average yield of canned grapefruit sections (cases of number 2 cans per box of fruit).

$\overline{Y}FC$ = average yield of frozen concentrated grapefruit juice (gallons per box of fruit).

The other variables were defined previously.

While the yields vary slightly from year to year, the variation is small enough so that the yields were treated as constant. The average yields and standard deviations, respectively, were 1.3464 and 0.0394 for single-strength juice, 1.2164 and 0.1436 for canned sections and 1.0198 and 0.0790 for frozen concentrated juice.

The pack of canned juice was chosen to be represented by the identity because of the error introduced by the use of average yields. Since the pack of the product is a residual in the identity, the resulting percentage error is smaller for that product since it accounts for a relatively larger share of the processed fruit.

Storage

Storage here refers to the inventory in processor warehouses at the end of a time period. Grapefruit products packed but not sold are placed in storage. The quantity in storage at the end of a time period was hypothesized to be a function of the FOB price of the product, the expected FOB price of the product and storage costs. As in the case of processing costs in the pack equations, storage costs and time were highly correlated. The correlation coefficient between storage costs and time was 0.89, so the year was used in place of storage costs. Finally, quantities of a product packed should influence inventory levels since any excess pack over current sales would move into storage. The storage relationships are given below.

$$(2\text{-}12)\quad SCS_{ms} = f(PFCS_{ms}, PFCS^*_{ms}, PCS_{ms}, s)$$

$$(2\text{-}13)\quad SCG_{ms} = f(PFCG_{ms}, PFCG^*_{ms}, PCG_{ms}, s)$$

$$(2\text{-}14)\quad SFC_{ms} = f(PFFC_{ms}, PFFC^*_{ms}, PFC_{ms}, s)$$

where SCS_{ms} = quantity of canned single-strength grapefruit juice in storage at end of month m in year s (million gallons).

SCG_{ms} = quantity of canned grapefruit sections in storage at end of month m in year s (million gallons single-strength).

SFC_{ms} = quantity of frozen concentrated grapefruit juice in storage at end of month m in year s (million gallons single-strength).

The other variables were defined previously.

Current and expected prices of a product were expected to have opposite effects on the quantity of that product. An increase in the current price should cause more of the product to be sold in the current time period, whereas a rise in the expected price should cause more of the product to be stored for sale at a later date at the expected higher price. Thus, $\partial SCS_{ms}/\partial PFCS_{ms} < 0$, while $\partial SCS_{ms}/\partial PFCS^*_{ms}$ and $\partial SCS_{ms}/\partial s > 0$. Relationships for (2-13) and (2-14) were expected to be similar to those described for (2-12).

Relationships for the expected prices were substituted into the equation of the storage of canned single-strength juice to obtain

$$(2\text{-}15)\quad SCS_{ms} = f[PFCS_{ms}, g_1(PFCS_{ms}, GE_{ms}), PCS_{ms}, s]$$

or

$$(2\text{-}16)\quad SCS_{ms} = f(PFCS_{ms}, GE_{ms}, PCS_{ms}, s)$$

Again the expected effect of the FOB price was both direct and indirect.

$$\frac{\partial SCS_{ms}}{\partial PFCS^*_{ms}} \cdot \frac{\partial PFCS^*_{ms}}{\partial PFCS_{ms}} + \frac{\partial SCS_{ms}}{\partial PFCS_{ms}} \gtrless 0$$

since the product was positive and $\partial SCS_{ms}/\partial PFCS_{ms} < 0$. The relative magnitudes of the partial derivatives determine the sign. $\partial SCS_{ms}/\partial GE_{ms}$ was expected to be < 0. The other sign expectations were unchanged. Similar reasoning was applied to (2-13) and (2-14), with similar results.

FOB Demand

FOB demand is directly related to retail demand. While the FOB level was hypothesized to be the critical pricing point throughout the industry, demand for a product at the FOB level is derived from the demand at the retail level. Therefore,

(2-17) $QFCS_{ms} = f(PFCS_{ms}$, retail demand for canned single-strength grapefruit juice)

(2-18) $QFCG_{ms} = f(PFCG_{ms}$, retail demand for canned grapefruit sections)

(2-19) $QFFC_{ms} = f(PFFC_{ms}$, retail demand for frozen concentrated grapefruit juice)

The formulation for the FOB demand for fresh grapefruit was somewhat different. Since the quantity of fresh grapefruit going to packers was hypothesized to be predetermined, the quantity at the FOB level was also predetermined. Consequently, the relationship was formulated with the FOB price of the product as a function of the FOB quantity and the retail demand.

(2-20) $PFFG_{ms}$ = f($QFFG_{ms}$, retail demand for fresh grapefruit)

canned juice

where $QFCS_{ms}$ = quantity of canned single-strength grapefruit juice demanded by buyers at the FOB level during month m of year s (million gallons).

$QFCG_{ms}$ = quantity of canned grapefruit sections demanded by buyers at the FOB level during month m in year s (million gallons single-strength).

frozen

$QFFC_{ms}$ = quantity of frozen concentrated grapefruit juice demanded by buyers at the FOB level during month m in year s (million gallons single-strength).

$QFFG_{ms}$ = quantity of fresh grapefruit available at the FOB level during month m in year s (million gallons single-strength).

Retail demand for each of the processed products was reflected by the retail quantity of the product, per capita disposable personal income and the retail prices of each of the products thought to be substitutes for the product. Also, to reflect seasonality in the demand for the product, the month and the month squared were included. For fresh grapefruit, retail quantities, rather than retail prices, were included. In the absence of retail quantity data, the preceding month's FOB sales, for processed products, were included as an approximate estimate of retail sales. A comparison of the turning points for FOB movement with those for household purchases, as reported by the Market Research Corporation of America [11], revealed approximately a one-month lag between FOB and retail sales. Income and retail price of substitutes were included as demand shifters. Texas grapefruit has been shown to be a substitute for Florida grapefruit [25]. The quantity of Texas grapefruit shipped was used, rather than the retail price, because there were no data available on retail prices of Texas grapefruit. Since retail prices were not available for the various grapefruit products, the corresponding FOB prices were used in place of the retail prices of the substitute products.

Dummy variables were added to the equations after a graphical analysis of prices and quantities revealed that there may have been a shift in demand for three of the products. If a shift had actually occurred, and this shift was not accounted for, erroneous results could be generated. For example, a shift may have occurred during the time period under consideration which would require two demand curves, one reflecting the demand before the shift and the other reflecting the demand after the shift. To ignore this shift would lead to a demand equation which did not reflect reality.

The FOB demand equations are given below.

$$(2\text{-}21)\ QFCS_{ms} = f(PFCS_{ms}, QFCS_{m-1,s}, IN_{ms}, POJ_{ms}, PFFC_{ms}, m, m^2)$$

$$(2\text{-}22)\ QFCG_{ms} = f(PFCG_{ms}, QFCG_{m-1,s}, IN_{ms}, PFFG_{ms}, TG_{ms}, m, m^2, D1)$$

$$(2\text{-}23)\ QFFC_{ms} = f(PFFC_{ms}, QFFC_{m-1,s}, IN_{ms}, PFCS_{ms}, POJ_{ms}, m, m^2, D2)$$

$$(2\text{-}24)\ PFFG_{ms} = f(QFFG_{ms}, IN_{ms}, QFCG_{ms}, TG_{ms}, m, m^2, D3)$$

where IN_{ms} = deflated per capita disposable personal income in month m and year s (thousands of dollars).

POJ_{ms} = deflated retail price of frozen concentrated orange juice during month m in year s (dollars per case of 6-ounce cans).

TG_{ms} = shipments of Texas grapefruit during month m of year s (million cartons).

$D1_s = \begin{cases} 1 \text{ if } 1967\text{-}68,\ 1968\text{-}69 \text{ or } 1970\text{-}71 \\ 0 \text{ if otherwise} \end{cases}$

$D2_s = \begin{cases} 1 \text{ if } 1965\text{-}66 \text{ or } 1966\text{-}67 \\ 0 \text{ if otherwise} \end{cases}$

$D3_s = \begin{cases} 1 \text{ if } 1967\text{-}68 \\ 0 \text{ if otherwise} \end{cases}$

The other variables were defined previously.

For each of the products, the income effect was expected to be positive. The own-price slopes were expected to be negative for the processed products, as was the own-quantity slope for fresh grapefruit. Since the lagged quantities were introduced as proxy variables for retail sales, they were expected to have positive slopes. There were no complementary relationships hypothesized, so each cross-product was viewed as a substitute product. As such, the cross-price slopes were expected to be positive. In equation (2-24), the cross-quantity slopes were expected to be negative. The expectations for the slopes of the dummy variables were $\partial QFCG_{ms}/\partial D1_s$ and $\partial PFFG_{ms}/\partial D3_s > 0$ and $\partial QFFC_{ms}/\partial D2_s < 0$.

Supply to Buyers at FOB Level

If the quantity of a product produced and the storage of that product are known, then the quantity supplied by processors for sale at the FOB level can be derived by tying together the three quantities via an identity. Thus, for each product there would be three equations with three unknowns, from which a solution can be obtained. The supply for each product is shown below to be equal to the inventory at the beginning of time period ms plus the pack of the product during time period ms minus the quantity in storage at the end of time period ms.

$$(2\text{-}25)\quad SUCS_{ms} = BCS_{ms} + PCS_{ms} - SCS_{ms}$$

$$(2\text{-}26)\quad SUCG_{ms} = BCG_{ms} + PCG_{ms} - SCG_{ms}$$

$$(2\text{-}27)\quad SUFC_{ms} = BFC_{ms} + PFC_{ms} - SFC_{ms}$$

where $SUCS_{ms}$ = quantity of canned single-strength grapefruit juice supplied to buyers at the FOB level during month m in year s (million gallons)

$SUCG_{ms}$ = quantity of canned grapefruit sections supplied to buyers at the FOB level during month m in year s (million gallons single-strength).

$SUFC_{ms}$ = quantity of frozen concentrated grapefruit juice supplied to buyers at the FOB level during month m in year s (million gallons single-strength).

BCS_{ms} = inventory of canned single-strength grapefruit juice at beginning of month m in year s (million gallons).

The other variables were defined previously.

Identities

To assume that, at the FOB level, supply equals demand, identities are needed in order to equate the two.

(2-28) $QFCS_{ms} = SUCS_{ms}$

(2-29) $QFCG_{ms} = SUCG_{ms}$

(2-30) $QFFC_{ms} = SUFC_{ms}$

Model II

During the months included in Model II, there is no grapefruit available for supply to packers or processors. Since fresh grapefruit cannot be stored, there can be no production of any of the products being considered in this study. Therefore, grower supply, processor demand, pack and fresh relationships that are part of Model I are no longer appropriate. Model II includes only the behavioral equations for storage and FOB demand plus the necessary identities.

Storage

The storage equations in Model I were formulated with the quantity of a product stored as a function of the FOB price of the product, the expected FOB price of the product, the quantity of the product packed and the storage cost. The quantity stored for Model II was hypothesized to be a function of the FOB price of the product, the expected FOB price of the product, storage cost and the month. As in Model I, the year was used in place of storage cost. Processors must insure that they are able to supply products at all times of the year, despite the fact that there is no production with which to replenish inventories. Therefore, the month becomes very important. The storage relationships are shown below.

(2-31) $SCS_{ms} = f(PFCS_{ms}, PFCS^*_{ms}, s, m)$

(2-32) $SCG_{ms} = f(PFCG_{ms}, PFCG^*_{ms}, s, m)$

(2-33) $SFC_{ms} = f(PFFC_{ms}, PFFC^*_{ms}, s, m)$

The variables are as defined previously.

The anticipated signs were similar to those for the storage equations for Model I. The fact that some of each product is sold each month implied that $\partial SCS_{ms}/\partial m$, $\partial SCG_{ms}/\partial m$ and $\partial SFC_{ms}/\partial m < 0$.

As in Model I, the expected price relationships were substituted into the storage equations. However, for Model II, the USDA crop estimate in the expected price equations was replaced by the actual size of the grapefruit crop, for the harvest period had ended. After the substitution, storage for canned single-strength juice became

$$(2\text{-}34)\quad SCS_{ms} = f(PFCS_{ms}, s, Q_s, m)$$

where Q_s = size of the Florida grapefruit crop in year s (million 1 3/5-bushel boxes).

It was not possible to determine the sign of $\partial SCS_{ms}/\partial PFCS_{ms}$ a priori for the same reasons given in Model I. The other three coefficients were expected to be negative.

FOB Demand

The reasoning for the FOB demand relationships during the months when there is no production was similar to that in Model I. There were only the three processed products, because of the nonavailability of fresh grapefruit during this period. The FOB demand equations are given below.

$$(2\text{-}35)\quad QFCS_{ms} = f(PFCS_{ms}, PFFC_{ms}, QFCS_{m-1,s}, IN_{ms}, POJ_{ms})$$

$$(2\text{-}36)\quad QFCG_{ms} = f(PFCG_{ms}, QFCG_{m-1,s}, IN_{ms})$$

$$(2\text{-}37)\quad QFFC_{ms} = f(PFFC_{ms}, QFFC_{m-1,s}, IN_{ms}, PFCS_{ms}, POJ_{ms})$$

The variables have been defined previously. The expected signs of the coefficients were similar to those for the respective equations in Model I.

Supply to Buyers at FOB Level

The FOB supply identities were similar to those in Model I. However, there was no new pack in the months of Model II.

(2-38) $SUCS_{ms} = BCS_{ms} - SCS_{ms}$

(2-39) $SUCG_{ms} = BCG_{ms} - SCS_{ms}$

(2-40) $SUFC_{ms} = BFC_{ms} - SFC_{ms}$

Identities

The following three identities show that FOB supply equals FOB demand.

(2-41) $QFCS_{ms} = SUCS_{ms}$

(2-42) $QFCG_{ms} = SUCG_{ms}$

(2-43) $QFFC_{ms} = SUFC_{ms}$

CHAPTER III

STATISTICAL CONSIDERATIONS

Statistical Model

The statistical models that were estimated are given below. The variables were defined in Chapter II. Endogenous variables are those variables whose values are determined jointly within the system. These variables are preceded by "β" coefficients. Exogenous variables, those whose values are determined outside of the system, are preceded by "γ" coefficients.

Model I

FOB Price Equations:

(3-1) $\beta_{11}PGK_{ms} + \beta_{12}PFFG_{ms} + \gamma_{10} + \gamma_{11}GK_{ms} = \mu_{1ms}$

(3-2) $\beta_{21}PGR_{ms} + \beta_{22}PFCS_{ms} + \beta_{23}PFCG_{ms} + \beta_{24}PFFC_{ms}$

$+ \gamma_{20} + \gamma_{21}S + \gamma_{22}GR_{ms} = \mu_{2ms}$

Pack:

(3-3) $GR_{ms} - \dfrac{PCS_{ms}}{4.54410} - \dfrac{PCG_{ms}}{4.01547} - \dfrac{PFC_{ms}}{4.02932} = 0$

(3-4) $\beta_{31}PCS_{ms} + \beta_{32}PFCS_{ms} + \beta_{33}PFCG_{ms} + \beta_{34}PFFC_{ms}$

$+ \gamma_{30} + \gamma_{31}GE_{ms} + \gamma_{32}BCS_{ms} + \gamma_{33}s + \gamma_{34}m$

$+ \gamma_{35}m^2 = \mu_{3ms}$

(3-5) $\beta_{41}PCG_{ms} + \beta_{42}PFCS_{ms} + \beta_{43}PFCG_{ms} + \beta_{44}PFFC_{ms}$

$+ \gamma_{40} + \gamma_{41}GE_{ms} + \gamma_{42}BCG_{ms} + \gamma_{43}s + \gamma_{44}m$

$+ \gamma_{45}m^2 = \mu_{4ms}$

Storage:

(3-6) $\beta_{51}SCS_{ms} + \beta_{52}PFCS_{ms} + \beta_{53}PCS_{ms} + \gamma_{50}$

$+ \gamma_{51}GE_{ms} + \gamma_{52}s = \mu_{5ms}$

(3-7) $\beta_{61}SCG_{ms} + \beta_{62}PFCG_{ms} + \beta_{63}PCG_{ms} + \gamma_{60}$

$+ \gamma_{61}GE_{ms} + \gamma_{62}s = \mu_{6ms}$

(3-8) $\beta_{71}SFC_{ms} + \beta_{72}PFFC_{ms} + \beta_{73}PFC_{ms} + \gamma_{70}$

$+ \gamma_{71}GE_{ms} + \gamma_{72}s = \mu_{7ms}$

FOB Demand:

(3-9) $\beta_{81}QFCS_{ms} + \beta_{82}PFCS_{ms} + \beta_{83}PFFC_{ms} + \gamma_{80}$

$+ \gamma_{81}QFCS_{m-1,s} + \gamma_{82}IN_{ms} + \gamma_{83}POJ_{ms} + \gamma_{84}m$

$+ \gamma_{85}m^2 = \mu_{8ms}$

(3-10) $\beta_{91}QFCG_{ms} + \beta_{92}PFCG_{ms} + \beta_{93}PFFG_{ms} + \gamma_{90}$

$+ \gamma_{91}QFCG_{m-1,s} + \gamma_{92}IN_{ms} + \gamma_{93}TG_{ms} + \gamma_{94}m$

$+ \gamma_{95}m^2 + \gamma_{96}D1_s = \mu_{9ms}$

(3-11) $\beta_{101}QFFC_{ms} + \beta_{102}PFFC_{ms} + \beta_{103}PFCS_{ms} + \gamma_{100}$
$+ \gamma_{101}QFFC_{m-1,s} + \gamma_{102}IN_{ms} + \gamma_{103}POJ_{ms} + \gamma_{104}m$
$+ \gamma_{105}m^2 + \gamma_{106}D2_s = \mu_{10ms}$

(3-12) $\beta_{111}PFFG_{ms} + \beta_{112}QFCG_{ms} + \gamma_{110} + \gamma_{111}QFFG_{ms}$
$+ \gamma_{112}TG_{ms} + \gamma_{113}IN_{ms} + \gamma_{114}m + \gamma_{115}m^2$
$+ \gamma_{116}D3_s = \mu_{11ms}$

Identities:

(3-13) $SUCS_{ms} - BCS_{ms} - PCS_{ms} + SCS_{ms} = 0$

(3-14) $SUCG_{ms} - BCG_{ms} - PCG_{ms} + SCG_{ms} = 0$

(3-15) $SUFC_{ms} - BFC_{ms} - PFC_{ms} + SFC_{ms} = 0$

(3-16) $QFCS_{ms} - SUCS_{ms} = 0$

(3-17) $QFCG_{ms} - SUCG_{ms} = 0$

(3-18) $QFFC_{ms} - SUFC_{ms} = 0$

Model II

Storage:

(3-19) $\beta_{121}SCS_{ms} + \beta_{122}PFCS_{ms} + \gamma_{120} + \gamma_{121}Q_s$
$+ \gamma_{122}s + \gamma_{123}m = \mu_{12ms}$

(3-20) $\beta_{131}SCG_{ms} + \beta_{132}PFCG_{ms} + \gamma_{130} + \gamma_{131}Q_s$
$+ \gamma_{132}s + \gamma_{133}m = \mu_{13ms}$

(3-21) $\beta_{141}SFC_{ms} + \beta_{142}PFFC_{ms} + \gamma_{140} + \gamma_{141}Q_s$

$+ \gamma_{142}s + \gamma_{143}m = \mu_{14ms}$

FOB Demand:

(3-22) $\beta_{151}QFCS_{ms} + \beta_{152}PFCS_{ms} + \beta_{153}PFFC_{ms} + \gamma_{150}$

$+ \gamma_{151}QFCS_{m-1,s} + \gamma_{152}IN_{ms} + \gamma_{153}POJ_{ms} = \mu_{15ms}$

(3-23) $\beta_{161}QFCG_{ms} + \beta_{162}PFCG_{ms} + \gamma_{160} + \gamma_{161}QFCG_{m-1,s}$

$+ \gamma_{162}IN_{ms} = \mu_{16ms}$

(3-24) $\beta_{171}QFFC_{ms} + \beta_{172}PFFC_{ms} + \beta_{173}PFCS_{ms} + \gamma_{170}$

$+ \gamma_{171}QFFC_{m-1,s} + \gamma_{172}IN_{ms} + \gamma_{173}POJ_{ms} = \mu_{17ms}$

Identities:

(3-25) $SUCS_{ms} - BCS_{ms} + SCS_{ms} = 0$

(3-26) $SUCG_{ms} - BCG_{ms} + SCG_{ms} = 0$

(3-27) $SUFC_{ms} - BFC_{ms} + SFC_{ms} = 0$

(3-28) $QFCS_{ms} - SUCS_{ms} = 0$

(3-29) $QFCG_{ms} - SUCG_{ms} = 0$

(3-30) $QFFC_{ms} - SUFC_{ms} = 0$

General Model

The two models can each be stated in matrix notation as

$$\beta Y + \Gamma X = \mu$$

where β is the JxJ matrix of coefficients of the J endogenous variables,

Y is the Jx1 vector of endogenous variables,

Γ is the JxK matrix of coefficients of the K exogenous variables,

X is the Kx1 vector of exogenous variables, and

μ is the Jx1 vector of disturbance terms.

For Model I, J = 18 and K = 19. For Model II, J = 12 and K = 11.

The following assumptions were made regarding the model.

(1) The matrix β is assumed to be non-singular, so that the system can be solved for the endogenous variables.

(2) $P_{\lim} T^{-1} X'X = \Sigma_{XX}$ where Σ_{XX} is the non-singular contemporaneous covariance matrix.

(3) The μ's are random variables with $E(\mu_{jms}) = 0$ (for $j=1,\ldots, J-L$; $s=1,\ldots, S$; for each value of $s, m=1,\ldots, M$). L is defined as the number of identities, S is the number of years and M is the number of months per year. The L identities are excluded because the coefficients are known.

(4) $E(\mu_{jms}\mu'_{int}) = \sigma_j^2$, if and only if $i=j$, $m=n$ and $s=t$ (for $i,j=1,\ldots, J-L$; $s,t=1,\ldots, S$ and $m,n=1,\ldots, M$ for each s).

(5) $E(\mu_{jms}\mu'_{int}) = 0$ when $i \neq j$ or $m \neq n$ or $s \neq t$ (for $i,j=1,\ldots, J-L$, $s,t=1,\ldots, S$ and $m,n=1,\ldots, M$ for each s).

Identification

The problem of identification must be considered prior to estimation of the structural coefficients of the model. If the parameter values in a relationship can be uniquely estimated, the relationship is said to be identified.

Consider one equation from a system of equations. The necessary or order condition for identifiability is that the number of exogenous variables excluded from the equation must be at least as great as the number of endogenous variables included minus one. This can be calculated as

$$H - h \geq g - 1$$

where H = the number of exogenous variables in the system,

h = the number of exogenous variables in the equation,

and g = the number of endogenous variables in the equation.

If H-h = g-1, the equation is said to be just-identified. If H-h > g-1, the equation is over-identified. In the event that H-h < g-1, the equation is not identified and the parameters cannot be uniquely estimated. The necessary conditions for identification indicate that each of the equations in Model I and Model II is over-identified.

The necessary and sufficient condition for identification is known as the rank condition. For an equation to be identified, it must be possible to form at least one non-zero determinant of rank J-1 from the coefficients of the variables excluded from the equation of interest, but which occur elsewhere in the system. J is the number of endogenous variables in the system.[1]

Estimation Procedure

Estimation of the coefficients of over-identified equations by ordinary least squares yields biased and inconsistent estimates. Estimates obtained by two-stage least squares (2SLS) are biased but consistent. Three-stage least squares (3SLS) is superior to 2SLS in its asymptotic efficiency because 3SLS incorporates restrictions associated with the specification of the structural equations in the system. Since the whole system of equations is estimated simultaneously, 3SLS estimates are more subject to specification errors. The list of all variables in the equation of interest plus the list of all exogenous variables in the system is needed for 2SLS. However, 3SLS requires the specification of all zero elements of the parameter matrix $[\Gamma'\beta']$, not just the row of that matrix corresponding to the particular equation. Thus, if an element is hypothesized to be zero when it is actually non-zero, this affects the 2SLS estimates of that particular equation only. In the case of 3SLS, estimates in all equations are affected [21, pp.528-529].

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[1] For a more detailed discussion of identification in the case of simultaneous equations, see Johnston [8, pp. 240-252].

However, the overriding consideration in the choice of estimation procedure was the unavailability of a 3SLS computer program capable of handling a model as large as that specified in Chapter II. Therefore, 2SLS was used to estimate the parameters in the two models.

Selection of Time Unit and Period

The time unit selected for this study was a month. At the FOB level, processors generally announce price increases two weeks in advance of the actual change. This gives buyers time to make their adjustments within the month. Also, the nature of the production pattern for grapefruit ruled out time units of less than a month. The quantity of grapefruit available in a particular month can be predicted more reliably than can the quantity available in a particular week. In other words, the production pattern over time is more constant from month to month than from week to week.

An additional consideration was the availability of data. Several data series are published on a monthly basis. While it was possible to sum the weekly data series to obtain monthly observations, it was not possible to convert the monthly observations to a weekly basis.

Data

Most of the data used in this study had to be transformed in some way before it could be used. The monthly data, after transformations, are given in Tables 9 to 14. All prices, with the exception of the retail price of frozen concentrated orange juice, were deflated by the wholesale price index (1957-59 = 100). On-tree prices and shipment data for grapefruit for fresh use are reported on a monthly basis by the Growers Administrative Committee and Shippers Advisory Committee [7]. Retail prices of frozen concentrated orange juice are reported monthly by Florida Citrus Mutual [6]. All other prices are reported weekly. Prices for seedy, white seedless and pink seedless grapefruit going to processors are reported by the United States Department of Agriculture [19], while the corresponding shipment data are reported by the Growers Administrative Committee and Shippers Advisory Committee [7]. To obtain a single price, the price of each of the three types of grapefruit was multiplied by its respective shipment quantity and the results were summed. This sum was then divided by the sum of the shipments for that month to yield a weighted average price.

FOB prices of processed products are published weekly by various processors in the form of price cards [1,2,12]. The prices for the different size containers and the various product forms, such as sugar added or sugarless, are reported.

For this study, the largest-selling container size and form was chosen as the representative one. Since the prices are reported on a weekly basis, it was necessary to weight the weekly prices by the respective FOB sales to obtain a single price for each month. FOB prices for fresh grapefruit are published as prices for Interior fruit and for Indian River fruit on a weekly basis by the Growers Administrative Committee and Shippers Advisory Committee [7]. To obtain a single price for each month, the product of the weekly prices times their quantities were summed and then divided by the total quantity for the month. After the monthly FOB prices and on-tree prices were derived, they were deflated by the monthly wholesale price index to convert them to constant dollars. The retail price of frozen concentrated orange juice was deflated by the consumer price index (1957-59 = 100).

The measure used for income was disposable personal income per capita, which is not reported directly. The series was obtained by subtracting reported personal taxes and non-tax payments from personal income each month and then dividing this by the population of the United States. Both population and personal income are reported monthly by the United States Department of Commerce [21], while personal income per capita was deflated by the consumer price index to adjust for the effect of inflation on income.

Data on pack, FOB movement and inventories for processed products are published in weekly series by the Florida Canners Association [3,5]. Beginning inventories and quantities in storage can be taken directly from the series. Pack and movement figures must be summed over the weeks in the month. The quantities of canned single-strength grapefruit juice and canned grapefruit sections, as reported, were in cases of 24 number 2 cans. Frozen concentrated grapefruit juice quantities are reported in gallons of 40° brix concentrate. To make all of the quantities comparable, they were converted to gallons of single-strength equivalent by multiplying single-strength juice and canned sections quantities by 3.375 and frozen concentrate juice quantities by 4.0. The conversion factor 3.375 converts cases of 24 number 2 cans to gallons of single-strength juice. The factor 4.0 converts concentrated juice to single-strength juice.

The quantities of fresh grapefruit at the FOB and grove levels are published as a monthly series by Florida Citrus Mutual [6] as boxes shipped. To convert boxes of fresh grapefruit to cases of 24 number 2 cans of single-strength juice, it was necessary to multiply the number of boxes times the yield of canned single-strength grapefruit juice. The yield for each month is available in published form from the Florida Canners Association [4]. To convert the cases of 24 number 2 cans to gallons, it was necessary to multiply by a factor of 3.375.

The quantity of grapefruit going to processors is the sum of the grapefruit, in boxes, used in each of the processed products. The quantity going to each product is published by Florida Canners Association [4] on a weekly basis in terms of cases of 24 number 2 cans. To get a monthly series, the weekly quantities were summed over the period of each month. The number of boxes were then obtained by dividing the number of cases packed by the respective yield for each product.

The shipments of Texas grapefruit are reported monthly by the Growers Administrative Committee and Shippers Advisory Committee [7].

Finally, the monthly United States Department of Agriculture's estimate of the size of the crop is published in the weekly report of the Florida Canners Association [3,5].

CHAPTER IV

STATISTICAL RESULTS

The results of the estimation of the coefficients are presented in this chapter. The standard errors are given in parenthesis below the respective coefficients. Consideration of the statistical significance of more than one coefficient in a particular equation requires a joint hypothesis. In the absence of a joint hypothesis, the testing of more than one coefficient results in a change in the probability of a Type I error. Therefore, no statistical tests were made.

Model I

On-Tree Price Equations

$$(4\text{-}1)\quad PGK_{ms} = -1.639 + \underset{(0.046)}{0.906}\ PFFG_{ms} - \underset{(0.127)}{0.173}\ GK_{ms}$$

$$(4\text{-}2)\quad PGR_{ms} = -1.797 + \underset{(0.067)}{0.665}\ PFCS_{ms} - \underset{(0.109)}{0.039}\ PFCG_{ms}$$

$$+ \underset{(0.088)}{0.117}\ PFFC_{ms} + \underset{(0.028)}{0.067}\ GR_{ms} - \underset{(0.018)}{0.039}\ s$$

The equations for the prices of grapefruit for packing and for processing were normalized on the on-tree price of grapefruit. The signs of the coefficients were in keeping with a priori expectations.

The coefficient of the FOB price of fresh grapefruit (PFFG) indicates that the on-tree price and the FOB price tend to move together. The importance of the FOB price in the relationship is shown by the fact that its estimated coefficient was more than 19 times as large as its standard error. The coefficient of the FOB price was 0.906. The margin between prices can be examined using the estimated equation above. Were the coefficient to be 1.0, margins would be unaffected by price levels, for a rise in the FOB price would correspond to an equal rise in the price that the growers receive. The coefficient of 0.906 implies that, as the price level increases, the absolute margin between the on-tree price and the FOB price increases slightly.

More than half of the grapefruit that is processed goes into the packing of canned single-strength grapefruit juice. Thus, it was expected that the on-tree price that the processors are willing to pay for grapefruit would be affected more by the canned single-strength juice FOB price than by the FOB prices of the other two processed products--canned sections and frozen concentrated juice. This was indeed the case. The coefficient of the FOB price of single-strength juice (PFCS) was over 17 times as large as that for the price of canned sections (PFCG), and almost six times as large as that for frozen concentrated juice (PFFC). The signs of the FOB price coefficients were as expected, with the exception of the FOB price of canned sections.

The year (s) was included as a proxy variable for processing costs, which were assumed to increase steadily from year to year. However, since the coefficient of the year was opposite of expectations, it may also represent other variables that have not been included but that also change steadily over time. One such variable might be changes in technology that reduce the cost of producing frozen concentrated grapefruit juice. Since the on-tree price is derived from the FOB prices of the three products, a cost-reducing change in technology would affect the price of the input, that input being grapefruit.

Pack Equations

$$\text{(4-3)} \quad PCG_{ms} = -0.166 - \underset{(0.265)}{0.411}\, PFCS_{ms} + \underset{(0.452)}{0.755}\, PFCG_{ms} - \underset{(0.346)}{0.133}\, PFC_{ms} + \underset{(0.182)}{0.184}\, BCG_{ms} - \underset{(0.087)}{0.199}\, s + \underset{(0.929)}{0.121}\, m - \underset{(0.079)}{0.133}\, m^2 + \underset{(0.033)}{0.079}\, GE_{ms}$$

$$\text{(4-4)} \quad PFC_{ms} = 16.100 + \underset{(1.030)}{0.807}\, PFCS_{ms} - \underset{(2.235)}{1.931}\, PFCG_{ms} + \underset{(1.389)}{1.447}\, PFFC_{ms} - \underset{(0.246)}{0.304}\, BFC_{ms} + \underset{(0.366)}{0.575}\, s - \underset{(2.892)}{5.821}\, m + \underset{(0.307)}{0.886}\, m^2 - \underset{(0.139)}{0.148}\, GE_{ms}$$

While the signs of the coefficients of the prices in equation (4-3) were as expected, equation (4-4) was less satisfactory in this respect. FOB prices entered the equations to measure two effects. One was the effect that the current FOB prices have on the pack of the products. The other was the effect on pack of the FOB prices that the processor expects to obtain for the products at a later date. It was shown earlier that the own-price slope should be positive while the cross-price slopes should be negative. In equation (4-4), the coefficient of the price of canned single-strength juice (PFCS) had a sign opposite from expectations. However, its coefficient was relatively small compared to its standard error.

Since canned sections is a product of declining importance and frozen concentrated juice an emerging one, the negative and positive, respectively, annual trends were in keeping with a priori expectations.

The net influence of the USDA crop estimate was composed of a negative component from the expected price relationship and a positive direct component. Since the coefficient of GE_{ms} in equation (4-3) was positive, it was concluded that the expected FOB price of the product had a less important impact on the production decision-maker than did the current USDA crop estimate. However, the sign of the coefficient in equation (4-4) was negative, implying the opposite relationship of that above.

Storage Equations

$$(4\text{-}5)\quad SCS_{ms} = 1.458 + \underset{(2.044)}{0.280}\ PFCS_{ms} + \underset{(0.325)}{1.749}\ PCS_{ms} + \underset{(0.690)}{0.117}\ s - \underset{(0.240)}{0.101}\ GE_{ms}$$

$$(4\text{-}6)\quad SCG_{ms} = 17.280 - \underset{(0.752)}{1.538}\ PFCG_{ms} - \underset{(0.186)}{0.397}\ PCG_{ms} + \underset{(0.161)}{0.161}\ s - \underset{(0.058)}{0.083}\ GE_{ms}$$

$$(4\text{-}7)\quad SFC_{ms} = 14.600 - \underset{(1.272)}{0.430}\ PFFC_{ms} + \underset{(0.141)}{1.008}\ PFC_{ms} + \underset{(0.332)}{1.014}\ s - \underset{(0.130)}{0.369}\ GE_{ms}$$

In equations (4-5) and (4-7), the coefficients for pack (PCS and PFC) are greater than one. It may appear unrealistic for inventory to increase by more than the quantity packed. It becomes much more reasonable when the meaning of the variables is made clear. A change in inventory, of course, refers to a change in the total quantity of the product in storage. However, a change in the pack refers to a change in the rate of pack, and not the change in the cumulative quantity packed in the year. Consider the case of canned single-strength juice for December, 1964, to January, 1965. The pack in December was 1,450,937 cases of number 2 cans, while the pack in January was 1,756,995. The inventory at the end of each month was 1,618,112 and 2,643,230 cases, respectively. From December to January, the inventory increased by 1,025,118 cases, the rate of pack increased by 306,058 cases, and the cumulative pack increased by 1,756,995 cases. Thus, an increase of 306,058 cases in the rate of pack corresponded to an increase of 1,025,118 cases in inventory. Thus, it is not unreasonable for the inventory to increase by more than the rate of change in pack.

As in the pack equations above, FOB prices of the products were both a reflection of the FOB prices in the current time period and the expected FOB prices of the products. The direct effect was expected a priori to be negative, while it was expected that producers would respond to changes in expected prices by adjusting inventories in the same direction as the price changes. The fact that the FOB price of canned single-strength juice (PFCS) had a positive coefficient, while the other two FOB prices (PFCG and PFFC) had negative coefficients, implies that the expected FOB price is relatively more important to processors when making storage decisions concerning single-strength juice, but that current prices are more important in decisions concerning the other two products.

The year was included as a proxy for storage costs. One normally expects storage costs and quantity stored to move in opposite directions. However, the coefficient of the year was positive in each equation. This indicates that the variable was possibly measuring the effect of one or more other variables, in addition to storage costs. One possible effect in the case of canned sections might be a declining sales trend and a failure to fully coordinate production with sales, with a resulting build-up of inventories. For the other two products, it is possible that the year variable was also measuring the increase in storage needed to meet increased demand.

The USDA crop estimate (GE) was found to have a negative relationship with storage. This was expected. Since the crop estimate entered the relationship via the expected price equation with an expected negative coefficient in that equation, the variable was also measuring the effect of the expected price on storage. An increase in the crop estimate would presumably affect storage decisions through the expectation of a fall in the whole spectrum of grapefruit product prices. This would cause a desire on the part of producers to sell more of the products in the current time period and put less into storage for sale at a later date when prices are expected to be lower.

<u>FOB Demand</u>

$$(4\text{-}8)\quad QFCS_{ms} = -10.380 - \underset{(0.509)}{0.549}\, PFCS_{ms} + \underset{(0.856)}{0.456}\, PFFC_{ms} + \underset{(4.097)}{6.590}\, IN_{ms} - \underset{(0.161)}{0.085}\, POJ_{ms} + \underset{(0.274)}{0.092}\, QFCS_{m-1,s} + \underset{(1.350)}{0.338}\, m - \underset{(0.138)}{0.027}\, m^2$$

$$(4\text{-}9)\quad QFCG_{ms} = 0.335 - \underset{(0.358)}{0.554}\, PFCG_{ms} - \underset{(0.099)}{0.080}\, PFFG_{ms}$$

$$+ \underset{(1.066)}{0.643}\, IN_{ms} + \underset{(0.216)}{0.334}\, D1_{s} - \underset{(0.216)}{0.272}\, TG_{ms}$$

$$+ \underset{(0.149)}{0.607}\, QFCG_{m-1,s} + \underset{(0.409)}{0.898}\, m - \underset{(0.042)}{0.105}\, m^{2}$$

$$(4\text{-}10)\quad QFFC_{ms} = 6.382 + \underset{(0.221)}{0.290}\, PFCS_{ms} + \underset{(0.420)}{0.076}\, PFFC_{ms}$$

$$- \underset{(1.605)}{1.531}\, IN_{ms} - \underset{(0.070)}{0.063}\, POJ_{ms} - \underset{(0.321)}{0.284}\, D2_{s}$$

$$+ \underset{(0.240)}{0.212}\, QFFC_{m-1,s} - \underset{(0.526)}{1.109}\, m + \underset{(0.055)}{0.149}\, m^{2}$$

$$(4\text{-}11)\quad PFFG_{ms} = 8.257 - \underset{(0.075)}{0.042}\, QFFG_{ms} - \underset{(0.234)}{0.368}\, QFCG_{ms}$$

$$+ \underset{(0.418)}{0.441}\, TG_{ms} - \underset{(1.811)}{2.346}\, IN_{ms} + \underset{(0.650)}{0.817}\, m$$

$$- \underset{(0.679)}{0.094}\, m^{2} + \underset{(0.394)}{1.963}\, D3_{s}$$

The estimation of the FOB demand equations yielded very acceptable results. The own-price slopes for single-strength juice, canned sections and fresh grapefruit (PFFG) were negative, as theory would lead one to expect. The own-price slope of frozen concentrated juice (PFFC), however, was positive, indicating that there is possibly an identification problem whereby supply has not been completely isolated from demand. However, the estimated coefficient for the FOB price of frozen concentrated juice was considerably smaller than its estimated standard error.

In equations (4-8) and (4-10), the signs of the coefficients of two products hypothesized as competing were positive as expected, implying that single-strength juice and frozen concentrated juice are indeed substitutes. In both equations, the coefficient of the price of concentrated orange juice (POJ) was negative. However, the estimated coefficient in each case was less than its estimated standard error.

It was anticipated that fresh grapefruit and canned grapefruit sections would be substitutes for one another. Also, since it has been shown that fresh Texas grapefruit (TG) and fresh Florida grapefruit substitute for one another to some extent [25], it was expected that canned sections and fresh Texas grapefruit would also substitute for one another. While the signs of the coefficients for fresh grapefruit in equation (4-9) and Texas grapefruit in (4-11) were the opposite of expectations, Texas grapefruit was found to substitute for canned sections.

Seasonality in the demand for each of the products was found to exist. For single-strength juice and canned sections, there is a tendency for demand to first increase and then decrease as the season progresses. The opposite seasonal effect was found for concentrated juice and fresh grapefruit with the demand increasing later in the season.

Disposable personal income (IN), as expected, exerts a positive influence on the demand for the first two products.

The negative coefficient for income in equation (4-10) was unexpected. However, the estimated coefficient of the disposable personal variable was less than the estimated standard error for that variable.

The coefficient of income in equation (4-11) was also negative. It is possible that consumers shift away from fresh grapefruit in favor of the more convenient processed grapefruit products as their income increases. Weisenborn, McPherson and Polopolus found that consumption of fresh oranges decreases with increases in income [26, pp. 19-20].

Since the value of the dummy variable (D2) in the concentrated juice equation was 1 in the early years of the study, the negative coefficient was as expected for an emerging product. The coefficient indicates that the demand has shifted upward during the later years of the study. Though canned sections has declined in importance, the sign of the coefficient of the dummy variable (D1) indicates that the demand for that product has also shifted upwards. The value of this variable was 0 in the earlier years of the study. This shift after the 1966-67 crop year possibly resulted from the large crop in 1966-67 and the resulting low prices. With the low prices, consumers may have become attached to the products and continued buying them in succeeding years.

The demand for fresh grapefruit shifted upwards during the 1967-68 crop year. This possibly was caused by the fact that the quality of the citrus crop in that year was especially good, resulting in consumers demanding more of the product at each price.

Model II

Storage Equations

$$\text{(4-12)}\quad SCS_{ms} = \underset{}{43.142} - \underset{(3.517)}{6.235}\, PFCS_{ms} + \underset{(0.925)}{0.980}\, s - \underset{(-.619)}{0.390}\, Q_s - \underset{(1.931)}{0.770}\, m$$

$$\text{(4-13)}\quad SCG_{ms} = 4.060 - \underset{(0.762)}{0.530}\, PFCG_{ms} + \underset{(0.119)}{0.142}\, s + \underset{(0.041)}{0.076}\, Q_s - \underset{(0.194)}{0.952}\, m$$

$$\text{(4-14)}\quad SFC_{ms} = -36.765 + \underset{(1.476)}{3.474}\, PFFC_{ms} - \underset{(0.312)}{1.262}\, s + \underset{(0.166)}{1.094}\, Q_s - \underset{(0.483)}{0.940}\, m$$

In theory, the storage equations for Model II were similar to those for Model I. The primary difference was that there was no pack during the months in Model II.

In the first two equations, the negative coefficients for the prices of the products imply that the current FOB price is a more important consideration in the decision-making process than is the expected price of the product. However, since Model II covered only the last three months of each season, it is possible that producers assume that the current price is the expected price.

As explained earlier, the positive trend for sections is possibly due to the fact that the processors have not fully coordinated their storage decisions with the declining importance of the product. The negative coefficient for the year in equation (4-14) was consistent with theory, since the year was included as a proxy variable for storage costs.

In each equation, the month had a negative coefficient, as expected. Since there is no pack, all of the sales must come from inventory, so it is expected to decrease from month to month. The coefficients of the quantity of grapefruit in a year were as expected in the latter two equations.

<u>FOB Demand</u>

$$(4\text{-}15)\quad QFCS_{ms} = 1.088 - \underset{(0.841)}{1.018}\, PFCS_{ms} + \underset{(2.064)}{0.769}\, PFFC_{ms} + \underset{(0.274)}{0.148}\, QFCS_{m-1,s} + \underset{(7.695)}{2.017}\, IN_{ms} - \underset{(0.307)}{0.121}\, POJ_{ms}$$

$$(4\text{-}16)\quad QFCG_{ms} = 2.088 - \underset{(0.173)}{0.554}\, PFCG_{ms} - \underset{(0.227)}{0.581}\, QFCG_{m-1,s} + \underset{(0.338)}{0.879}\, IN_{ms}$$

$$(4\text{-}17)\quad QFFC_{ms} = -9.320 - \underset{(0.996)}{0.718}\, PFFC_{ms} + \underset{(0.365)}{0.327}\, PFCS_{ms} + \underset{(0.192)}{0.200}\, QFFC_{m-1,s} + \underset{(4.004)}{4.224}\, IN_{ms} + \underset{(0.154)}{0.092}\, POJ_{ms}$$

The estimated coefficients in the equations for FOB demand for both single-strength juice and canned sections for Model II were very similar to those for Model I, especially with respect to signs. However, the equation for frozen concentrated juice was closer to expectations than was the equation in Model I. The own-price slope for concentrated grapefruit juice was found to be negative. The resulting demand elasticities for Model I and Model II are compared in the next chapter.

CHAPTER V

ECONOMIC IMPLICATIONS

This chapter is divided into three sections. In the first section, estimates of elasticities and implications based on these estimates are presented. The second section deals with an analysis of the derived reduced forms for the two models. Finally, in the third section, the results of short-term forecasting based on the reduced forms are presented.

Elasticities

The estimates of the demand elasticities and cross elasticities for grapefruit products at the FOB level for Model I are presented in Table 2.[1] The elasticities for processed grapefruit products at the FOB level were calculated directly from the demand equations as estimated. Since the FOB demand equation for fresh grapefruit was estimated with price as a function of quantity, it was necessary to solve it for the quantity demanded in terms of prices and income.

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[1]Elasticity estimates should be interpreted with caution in the case of simultaneous equation models. Elasticities are based on the assumption of *ceteris paribus*. However, in a simultaneous equation model, a change in an endogenous variable would result in changes in other endogenous variables within the system to restore the equilibrium. Hence, the assumption that all other endogenous variables remain constant is not fulfilled.

Table 2. Elasticities and Cross Elasticities of Demand at the FOB Level for Grapefruit in Various Forms, Computed at Mean Values of the Variables, Model I, 1964-71

Normalized Variable	Elasticities or Cross Elasticities with Respect to:					
	PFCS	PFCG	PFFC	PFFG	POJ	IN
QFCS	-0.392	--	0.309	--	-0.268	3.216
QFCG	--	-2.101	--	-0.270	--	1.219
QFFC	0.654	--	0.163	--	-0.622	-2.357
QFFG	--	2.874[a]	--	-12.268[a]	--	-1.667[a]

[a]Computed by solving the estimated demand function for the quantity in terms of prices and income.

The cross elasticity estimates presented in Table 2 indicate that none of the products are very strong substitutes for one another at the FOB level. A positive cross elasticity is required for substitute goods and a negative one for complementary goods. Based on the measures given in Table 2, frozen concentrated grapefruit juice and canned single-strength juice are substitutes for each other. This is really not surprising since they are simply two forms of the same product.

The cross elasticity measures for canned sections and fresh grapefruit conflict somewhat. One elasticity measure indicates that the two products are substitutes, while the other indicates that they are complementary.

Based on the cross elasticity estimates, concentrated orange juice is shown to be complementary to both single-strength juice and frozen concentrated juice. However, as indicated earlier, the estimated coefficients for concentrated orange juice were less than their respective estimated standard errors.

The income elasticities given in Table 2 show that in a period of rising income, the quantity demanded of canned single-strength juice and canned sections would increase, while the quantity demanded of frozen concentrated juice and fresh grapefruit would decrease. An increase in disposable personal income per capita of 1 percent would result in increases in the FOB demand of single-strength juice and canned sections of slightly over 3 percent and 1 percent, respectively. Also, the FOB demand for frozen concentrated juice and fresh grapefruit would decrease by more than 2 percent and 1.5 percent, respectively.

The elasticities and cross elasticities of demand for the three products in Model II are given in Table 3. In each case, the equation was normalized on the quantity variable for estimation, making the price-quantity slope, as estimated, appropriate for computing elasticities directly.

The elasticities for Model II are much closer to theoretical expectations than were those for Model I in that all elasticity measures have the expected signs. In

Table 3. Elasticities and Cross Elasticities of Demand at the FOB Level for Grapefruit in Various Processed Forms, Computed at Mean Values of the Variables, Model II, 1964-70

Normalized Variable	Elasticities or Cross Elasticities with Respect to:			
	PFCS	PFCG	PFFC	IN
QFCS	-1.254	--	.825	1.532
QFCG	--	-2.636	--	2.094
QFFC	1.097	--	-2.096	8.734

contrast to Model I, all of the products have negative demand elasticities.

The demand for each of the products is shown to be more elastic during the months of Model II. During these months, the demand for canned sections and frozen concentrated juice is more responsive to changes in income. The demand for single-strength juice responds about half as much as during the months of Model I.

As in Model I, canned single-strength juice and frozen concentrated juice are shown to be substitutes. Both elasticity measures are larger than their respective measures in Model I, implying that, during the months in Model II, consumers respond more readily to changes in the prices of the substitutes.

The elasticities of the two models can be compared. In general, consumers are more responsive to changes in prices and income during July, August and September than during the other nine months of the year. This possibly results from the importance that consumers place on the cold-preventing properties inherent in citrus products. During the summer months, consumers are less interested in preventing colds than they are in the winter months, so they may choose to substitute carbonated beverages and other fruit drinks for the grapefruit beverages as thirst quenchers. Therefore, during the months of Model II, there are more substitute products available, which typically has the effect of making consumers more responsive to price.

Implications from the Derived Reduced Form Estimates

Reduced form equations describe each endogenous variable in terms of all exogenous variables in the system. The direct reduced form is identical to the first stage of the two-stage least squares procedure. It is obtained from

$$Y = \hat{\Gamma}X + \mu$$

where $\hat{\Gamma}$ is the matrix of direct estimates of the reduced form. The derived reduced form estimates are obtained from

$$Y = -\hat{\beta}^{-1}\,\hat{\gamma}X + \hat{\beta}^{-1}\mu$$

where $-\hat{\beta}^{-1}\hat{\gamma} = \hat{\Pi}$ is the matrix of derived reduced form esti-

The derived and direct reduced form estimates for Model I are given in Tables 4 and 15, respectively. Those for Model II are given in Tables 5 and 19, respectively. In this section, implications based on the derived reduced form are discussed for Model I. A similar discussion follows for Model II, at which time the two models are compared.

In Model I, increases in personal disposable income per capita would increase the FOB demand for each of the products, with the exception of canned sections. For single-strength juice and frozen concentrated juice, the FOB prices and quantities demanded would increase. Also, the FOB price of fresh grapefruit would increase. For canned sections, the FOB price would increase, but there would be a corresponding decrease in the quantity demanded.

The increases in revenue would not be restricted to processors. Growers would also benefit. Whereas the quantity of grapefruit going to processing and to packing is predetermined, increased on-tree prices would mean increased returns for the growers. Thus, in a period of rising income, such as has consistently occurred in recent years, the Florida grapefruit industry as a whole would receive increased revenues.

The effect of beginning inventories can also be examined. If the industry were to initiate a program to increase inventories, perhaps to be able to provide more of the products during the months of Model II or to provide a cushion in the event of a freeze, the result would be an

Table 4. Coefficients of Derived Reduced Form Equations for Model I

Exogenous Variable[a]	Endogenous Variable[a]					
	PGR	PGK	PFCS	PFCG	PFFC	PFFG
IN	7.149	1.959	10.208	2.372	4.262	2.163
BCS	-0.810	-0.047	-1.072	-0.248	-0.918	-0.052
BCG	-0.437	-0.102	-0.600	-0.535	-0.496	-0.112
BFC	1.285	0.062	2.143	0.325	-1.090	0.068
m	5.585	0.806	7.911	1.852	3.392	0.889
m^2	-0.684	-0.085	-0.972	-0.172	-0.378	-0.093
s	-1.187	-0.027	-1.962	-0.142	1.286	-0.030
TG	-0.078	0.481	-0.109	-0.125	-0.089	0.532
POJ	-0.002	-0.001	0.025	-0.005	-0.161	-0.001
GE	0.315	0.002	0.577	0.009	-0.583	0.002
D1	0.085	-0.089	0.119	0.136	0.097	-0.098
D2	0.305	0.014	0.529	0.074	-0.375	0.016
D3	-0.040	1.820	-0.055	-0.064	-0.045	2.009
QFCS[b]	0.075	0.004	0.100	0.023	0.085	0.005
QFCG[b]	0.154	-0.161	0.216	0.247	0.176	-0.178
QFFC[b]	-0.227	-0.011	-0.394	-0.055	0.280	-0.012
GR	2.823	0.160	3.647	0.845	3.122	0.177
GK	0.000	-0.173	0.000	0.000	0.000	0.000
QFFG	0.001	-0.039	0.001	0.001	0.001	-0.043
Constant	-38.353	5.141	-57.386	-4.263	12.216	7.485

Table 4. (continued)

Exogenous Variable[a]	Endogenous Variable[a]				
	PCS	QFCS,SUCS	SCS	PCG	QFCG,SUCG
IN	-7.723	2.924	-10.647	-2.968	-0.499
BCS	1.508	0.171	2.338	0.375	0.142
BCG	0.086	0.104	-0.018	0.092	0.305
BFC	1.433	-1.674	3.107	-0.490	-0.185
m	0.327	-2.462	2.789	-2.181	-0.198
m^2	-0.083	0.335	-0.418	0.187	-0.002
s	-1.643	1.664	-3.307	0.329	0.081
TG	0.015	0.019	-0.005	-0.038	-0.245
POJ	0.221	-0.172	0.393	0.007	0.003
GE	0.670	-0.583	1.279	-0.074	-0.005
D1	-0.016	-0.021	0.005	0.041	0.266
D2	0.418	-0.461	0.880	-0.112	-0.042
D3	0.008	0.010	-0.002	-0.019	-0.125
QFCS[b]	-0.139	0.077	-0.216	-0.035	-0.013
QFCG[b]	-0.029	-0.038	0.009	0.075	0.484
QFFC[b]	-0.312	0.344	-0.656	0.083	0.031
GR	-0.589	-0.581	-0.009	-1.275	-0.482
GK	0.000	0.000	0.000	0.000	0.000
QFFG	-0.001	-0.001	0.000	0.000	0.003
Constant	-16.136	26.708	-42.884	18.564	2.101

Table 4. (continued)

Exogenous Variable[a]	Endogenous Variable[a]			
	SCG	PFC	QFFC,SUFC	SFC
IN	-2.469	9.826	1.753	8.073
BCS	0.233	-1.713	-0.381	-1.333
BCG	0.787	-0.169	-0.212	0.043
BFC	-0.305	-0.779	0.538	-0.317
m	-1.982	1.898	1.443	0.454
m^2	0.190	-0.114	-0.162	0.047
s	0.248	1.127	-0.470	1.597
TG	0.207	0.025	-0.038	0.063
POJ	0.005	-0.203	-0.068	-0.135
GE	-0.068	-0.544	0.123	-0.667
D1	-0.225	-0.027	0.042	-0.069
D2	-0.069	-0.259	-0.159	-0.100
D3	0.105	0.013	-0.020	0.032
QFCS[b]	-0.022	0.158	0.035	0.123
QFCG[b]	-0.410	-0.049	0.076	-0.125
QFFC[b]	0.052	0.193	0.119	0.074
GR	-0.793	5.830	1.296	4.535
GK	0.000	0.000	0.000	0.000
QFFG	-0.002	-0.001	0.000	-0.001
Constant	16.464	-4.315	-9.314	4.999

[a]Variables are as defined in Chapter II.

[b]Quantity lagged one month.

Table 5. Coefficients of Derived Reduced Form Equations for Model II

Exogenous Variable[a]	Endogenous Variable[a]								
	PFCS	PFCG	PFFC	QFCS,SUCS	QFCG,SUCG	QFFC,SUFC	SCS	SCG	SFC
IN	0.114	0.811	-1.546	0.712	0.430	5.370	-0.712	-0.430	-5.370
Q	-0.095	0.070	-0.386	-0.200	-0.039	0.246	0.200	0.039	-0.246
m	-0.069	-0.879	0.349	0.339	0.486	-0.273	-0.339	-0.486	0.273
POJ	-0.020	0.000	-0.031	-0.125	0.000	0.108	0.125	0.000	-0.108
QFCS[b]	0.020	0.000	-0.002	0.126	0.000	0.008	-0.126	0.000	-0.008
QFCG[b]	0.000	-0.536	0.000	0.000	-0.284	0.000	0.000	0.284	0.000
QFFC[b]	-0.008	0.000	-0.072	-0.047	0.000	0.249	0.047	0.000	-0.249
s	0.181	0.131	0.436	0.151	-0.072	-0.254	-0.151	0.072	0.254
BCS	-0.136	0.000	0.016	0.151	0.000	-0.056	0.849	0.000	0.056
BCG	0.000	-0.923	0.000	0.000	0.511	0.000	0.000	0.489	0.000
BFC	0.038	0.000	0.358	0.237	0.000	-0.245	-0.237	0.000	1.245
Constant	7.773	5.672	15.796	5.320	-1.052	-18.114	-5.320	1.052	18.114

[a]Variables are defined in Chapter II.

[b]Quantities are lagged one month.

increase in the level of pack. Also, FOB sales would be increased. However, perhaps because the impetus would come from the supply side, the FOB prices of each of the products would decrease. The price of single-strength juice, which accounts for about 55 percent of the grapefruit processed, would decrease by approximately one-third, while the movement would increase by less than 4 percent. In addition, though not given in the reduced forms, there would likely be increases in the cost of storing the increased inventories. Therefore, during the months of Model I, it appears that revenue to producers would decrease. However, as shown later, revenues during the months represented by Model II would increase.

Increases in Texas grapefruit is shown to adversely affect the Florida industry. Increases in Texas grapefruit shipments would depress prices for all three processed grapefruit products and, consequently, the price that growers receive for grapefruit going to processing would decline. Also, the price of grapefruit for fresh sales would decrease. Fortunately for the Florida industry, Texas shipments are annually only about 3 percent as large as the Florida crop.

Based on the coefficients for the FOB prices in the reduced form equations, increases in the price of frozen concentrated orange juice would adversely affect the prices of canned sections and frozen concentrated grapefruit juice. The fresh market for grapefruit would be unaffected by changes in the price of frozen concentrated orange juice.

Finally, changes in the FOB quantity of fresh grapefruit would have virtually no effect on the other products in the study. The effect of a decrease in the FOB quantity, perhaps caused by a freeze, would be an increase in both the on-tree and FOB price for fresh grapefruit.

For Model II, increases in income would result in increased demand for single-strength juice and canned sections, with prices and quantities both increasing. Income increases would result in an increased volume of sales of frozen concentrated juice; however, there would be a net decrease in price. Since frozen concentrated juice represents a relatively small share of the grapefruit market, rising income would clearly result in increased revenues to the industry.

Whereas in Model I, single-strength juice was shown to be a substitute for frozen concentrated orange juice, the reduced form for Model II tends to substantiate the findings based on the cross elasticity for the two products. The cross elasticity was negative, indicating complementarity. Were the price of the orange product to increase, both the quantity and the price of single-strength juice would decrease while the storage of the product would increase. Further, the price of frozen concentrated grapefruit juice would decline while the FOB movement would increase.

In Model I, it was shown that the gains from increased inventories would be questionable. However, if they were to be increased during the months in Model I and were carried over to give higher inventory levels during the months of

Model II, net revenue to producers would increase. For single-strength juice and canned sections, sales would be increased, while prices would decline. However, based on the elasticity estimates, decreases in the prices would be more than offset by increases in sales.

Short-Term Forecasting

Forecasts of the values of the variables endogenous to the Florida grapefruit industry can prove invaluable to the growers, packers and processors within the industry by reducing uncertainties. Based on the expected values of the exogenous variables, the decision makers within the industry could determine the economic consequences of following their established decision criteria. For example, once the size of the grapefruit crop for the coming year is predicted, the values of all of the endogenous variables can be forecast. This assumes that it is possible to obtain acceptable predictions for the other exogenous variables.

To avoid the necessity of having to actually simultaneously solve the equations in the model to determine the values of the endogenous variables each time a change occurs in the exogenous variables, the reduced form of the system is used. The forecasts based on these reduced form equations are only for the short term. When forecasting with a static model, the assumption is made that the structure of the system will remain as it was during the period of data used for estimation of the structure. Thus, a model that yields satisfactory forecasts for the short term may be inadequate for long-term predictions because of changes in the structure.

There are several methods that can be used to evaluate the resulting forecasts. Each method requires that predictions be made for a period in which the values for both the endogenous and exogenous variables are known, so that the model's predicted values can be compared with the actual values that occurred. To avoid biasing the comparison, data used in testing the model should not have been used in the estimation of the model. One test involves the ability of the model to predict turning points. The turning points that are predicted are compared with the turning points that actually occurred. This test was inappropriate to the present study because of the lack of turning points over the range of the data for each production season.

Another test attempts to give an objective measure of how close the predictions are to the actual values by considering the magnitude of the predictions relative to the actual values. In addition, the ability of the model to predict changes in the endogenous variables is also included. This measure is known as Theil's inequality coefficient [16, p. 28 and 17, p. 32].

$$U_1 = \frac{\sqrt{\sum_j (P_j - A_j)^2}}{\sqrt{\sum_j (A_j - A_{j-1})^2} + \sqrt{\sum_j (P_j - A_{j-1})^2}}$$

and

$$U_2 = \frac{\sqrt{\sum_j (P_j - A_j)^2}}{\sqrt{\sum_j (A_j - A_{j-1})^2}}$$

where P_j is the predicted value of the endogenous variable and A_j is the actual value.[2]

U_1 is confined to values between 0 and 1. A value of 0 implies that $P_j = A_j$ for all j, so that the forecasts are perfect. A value of $U_1 = 1$ implies the extreme case where nonzero predictions are made of actual values that are 0 or vice-versa (i.e., $P_j = 0$ for all j or $A_j = 0$ for all j). Or it means that there is a nonpositive proportionality between the P's and the A's.

A value of 0 for U_2 likewise denotes perfect forecasting. If a no-change extrapolation is applied (i.e., that the value in time period j is predicted to be the same as occurred in time period j-1), then $P_j = A_{j-1}$. In that case, the numerator and the denominator are equal and $U_2 = 1$. The

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[2]The coefficients, U_1 and U_2, are typically given as

$$U_1 = \sqrt{\sum_i (P_i - A_i)^2} \div \left\{\sqrt{\sum_i (A_i)^2} + \sqrt{\sum_i (P_i)^2}\right\}$$

and

$$U_2 = \sqrt{\sum_i (P_i - A_i)^2} \div \sqrt{\sum_i (A_i)^2}$$

where the A_i and P_i refer to changes in the actual value and the predicted value, respectively. The A_j and P_j that appear in the formulations in the text are actual values, rather than changes. For the derivation of the formulations in the text, see Stekler [15, p. 439].

coefficient has no upper bound, so a value greater than 1 implies that the forecast is worse than could be obtained by using a no-change extrapolation.

Thus, in the cases of both U_1 and U_2, values close to 0 are indicative of accuracy in forecasting, whereas values approaching 1 indicate that a no-change extrapolation would have performed about as well. If $U_2 > 1$, a no-change extrapolation would have been preferable.

The predicted values of the endogenous variables for Model I, based on the estimated reduced form, are given in Table 6. Table 6 also includes the actual values for the variables and the deviations of the predicted values from the actual values. Predictions based on the estimated reduced forms rather than on the derived reduced forms are presented in the text because, evaluated on the basis of the inequality coefficients, they were closer to the actual values. The calculated inequality coefficients, U_1 and U_2, are given in Table 7. While the discussion in the text is based on the results presented in Tables 6 and 7, predicted values and inequality coefficients based on the derived reduced forms are presented in Tables 16 and 17. Data used in forecasting are given in Table 18.

Based on the inequality coefficients, the model predicted the storage of canned single-strength juice fairly well. Also, the values for storage and FOB quantity of frozen concentrated juice were fairly accurate. However,

Table 6. Endogenous Variables: Actual Values, Predicted Values Based on the Reduced Form Estimated Directly and Deviations, December, 1971, Through March, 1972

Variable[a]		Month			
		December	January	February	March
PGR ($/box)	Actual	.92	.93	.92	.88
	Predicted	.41	.24	.23	-.16
	Deviation[b]	.51	.69	.69	1.04
PGK ($/box)	Actual	1.54	1.49	1.44	1.34
	Predicted	1.61	1.60	2.00	2.13
	Deviation	-.07	-.11	-.56	-.79
PFCS ($/case)	Actual	4.72	4.58	4.51	4.07
	Predicted	3.85	3.30	3.15	2.38
	Deviation	.87	1.28	1.36	1.69
PFCG ($/case)	Actual	5.46	5.30	5.37	5.41
	Predicted	5.01	5.28	5.42	5.80
	Deviation	.45	.02	-.05	-.39
PFFC ($/case)	Actual	3.97	3.85	3.80	3.83
	Predicted	3.37	3.61	4.07	4.27
	Deviation	.60	.24	-.27	-.44
PFFG ($/box)	Actual	5.40	5.24	5.10	4.90
	Predicted	3.22	3.10	3.45	3.35
	Deviation	2.18	2.14	1.65	1.55
PCS (mil. gal.)	Actual	10.007	11.853	13.202	15.416
	Predicted	11.264	14.476	14.866	21.338
	Deviation	-1.256	-2.624	-1.664	-5.923
PFCS, SUCS (mil. gal.)	Actual	5.494	5.087	4.978	6.728
	Predicted	8.539	10.109	10.629	13.892
	Deviation	-3.044	-5.022	-5.651	-7.164
SCS (mil. gal.)	Actual	10.511	17.277	25.501	34.188
	Predicted	8.753	14.910	21.546	32.984
	Deviation	1.759	2.367	3.954	1.204
PCG (mil. gal.)	Actual	2.706	2.064	1.361	0.448
	Predicted	3.073	3.979	3.317	3.622
	Deviation	-0.367	-1.915	-1.956	-3.174

Table 6. (continued)

Variable[a]		Month			
		December	January	February	March
QFCG, SUCG (mil. gal.)	Actual	0.935	0.824	0.978	0.948
	Predicted	-0.599	0.301	0.853	0.945
	Deviation	1.535	0.523	0.126	0.003
SCG (mil. gal.)	Actual	4.610	5.850	6.233	5.732
	Predicted	6.496	8.265	8.292	8.887
	Deviation	-1.885	-2.415	-2.059	-3.155
PFC (mil. gal.)	Actual	4.528	3.495	4.043	13.891
	Predicted	0.172	-2.479	-0.121	4.518
	Deviation	4.356	5.974	4.164	9.373
QFFC, SUFC (mil. gal.)	Actual	2.248	1.265	1.389	2.867
	Predicted	2.328	1.583	1.839	1.884
	Deviation	-0.080	-0.319	-0.451	0.984
SFC (mil. gal.)	Actual	6.871	9.102	11.756	22.779
	Predicted	2.437	2.817	7.154	14.406
	Deviation	4.434	6.284	4.601	8.373

[a]Variables are as defined in Chapter II.

[b]Actual value minus predicted value.

Table 7. Theil's Inequality Coefficients for Predicted Values of the Endogenous Variables, Based on Reduced Form Estimated Directly, December, 1971, Through March, 1972

Endogenous Variable	U_1[a]	U_2[b]
PR	0.9520	33.5867
PK	0.9919	7.9318
PFCS	0.7407	5.3877
PFCG	0.5946	2.1762
PFFC	0.7445	4.2819
PFFG	0.8440	10.6775
PCS	0.5168	2.1020
QFCS, SUCS	0.7851	5.7869
SCS	0.2034	0.3466
PCG	0.9978	3.1768
QFCG, SUCG	0.6495	2.7952
SCG	0.6858	3.2185
PFC	0.6662	1.1968
QFFC, SUFC	0.4045	0.6337
SFC	0.6817	0.9896

[a] $$U_1 = \sqrt{\sum_{j=2}^{4} (P_j - A_j)^2} \div \left[\sqrt{\sum_{j=2}^{4} (A_j - A_{j-1})^2} + \sqrt{\sum_{j=2}^{4} (P_j - A_{j-1})^2}\right]$$

where A_j = actual value (j = 2, 3, 4)

P_j = predicted value (j = 2, 3, 4)

[b] $$U_2 = \sqrt{\sum_{j=2}^{4} (P_j - A_j)^2} \div \sqrt{\sum_{j=2}^{4} (A_j - A_{j-1})^2}$$

for all the other variables, the values of U_2 were > 1. This implies that a no-change extrapolation would have been preferable to the predicted values.

If evaluated with respect to the values of U_1, the model performs somewhat better. The closer the value of U_1 is to 1, the closer the predictions get to the no-change extrapolation value. Eight of the 18 variables had U_1 values less than 0.7, indicating that the predictions may not be as bad as indicated by the U_2 values. This is not to imply that 0.7 is the value below which the predictive ability of the model is acceptable; there is no test to indicate how much better a particular value of U_1 is than another. Overall, with the few exceptions noted, it appears that the predictive ability of Model I is not very sharp.

The predicted values based on the derived reduced forms, actual values and deviations for Model II are presented in Table 8, while the predictions based on the estimated reduced form are presented in Table 20. The data used in obtaining the predictions are given in Table 21. No inequality coefficients were calculated for Model II because there were only two months of data available that were not used in the estimation. Any attempts to draw conclusions as to the predictive ability of the model would be suspect. However, several observations can be made. In general, the predictions based on the two reduced forms did not differ widely, though, based on observation alone, the predictions

Table 8. Endogenous Variables: Actual Values, Predicted Values Based on the Derived Reduced Forms and Deviations, August and September, 1971

Variable		Month	
		August	September
PFCS	Actual	4.51	4.68
($/gal.)	Predicted	3.53	3.88
	Deviation[a]	0.98	0.80
PFCG	Actual	5.22	5.42
($/gal.)	Predicted	5.90	5.72
	Deviation	-.68	-.30
PFFC	Actual	3.80	3.94
($/gal.)	Predicted	3.09	2.56
	Deviation	0.71	1.38
QFCS, SUCS	Actual	3.875	4.454
(mil. gal.)	Predicted	3.953	3.042
	Deviation	0.078	1.412
QFCG, SUCG	Actual	0.751	0.987
(mil. gal.)	Predicted	0.594	0.703
	Deviation	0.157	0.284
QFFC, SUFC	Actual	2.099	2.710
(mil. gal.)	Predicted	1.831	2.504
	Deviation	0.268	0.206
SCS	Actual	9.798	5.343
(mil. gal.)	Predicted	9.719	6.756
	Deviation	0.078	-1.412
SCG	Actual	3.100	2.113
(mil. gal.)	Predicted	3.257	2.397
	Deviation	-0.157	-0.284
SFC	Actual	8.899	7.189
(mil. gal.)	Predicted	10.167	7.395
	Deviation	-1.268	-0.206

[a]Actual value minus predicted value.

using the derived reduced form were slightly more accurate. Also, both reduced forms for Model II predicted better than did either reduced form for Model I.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The first part of the present chapter consists of a summary of the objectives and findings of the study. Conclusions based on the findings are presented in the second section. Finally, suggestions are made as to further research that is needed for a fuller understanding of the Florida grapefruit industry.

Summary

The objectives of this study were (1) to quantitatively describe, by means of an econometric model, the Florida grapefruit industry from the grower transactions at harvest to the FOB level for canned single-strength juice, canned sections, frozen concentrated juice and fresh grapefruit; (2) to measure the effects of factors exogenous to the Florida grapefruit industry on the production and sale of the four products listed above; and (3) to develop a model for forecasting values of the variables endogenous to the Florida grapefruit industry.

Two models were developed: one for the months in which fruit was harvested and thus available for processing and for fresh pack (Model I) and one for the months when no fruit was harvested (Model II). Model I consisted of 11 behavioral equations and 7 identities for the crop years from 1964-65 to 1970-71. Model II consisted of six behavioral equations and six identities for the crop years 1963-64 through 1969-70. Included in Model I were behavioral relationships for (1) on-tree prices for grapefruit for packing and for processing, (2) pack for each of canned grapefruit sections and frozen concentrated grapefruit juice, (3) storage of each of the processed products, and (4) FOB demand for each of the processed products, as well as FOB demand for fresh grapefruit. The behavioral relationships for Model II include (1) storage of each of the processed products and (2) FOB demand for each of the processed products. All of the behavioral equations were overidentified and were estimated using two-stage least squares. Monthly data were used.

The processor and packer on-tree price equations were each formulated with the on-tree price as a function of the other variables. All of the other equations were normalized on quantity. Both the quantity demanded and the prices of the products to be derived from the fruit were shown to affect the prices that the buyers were willing to pay. Also, for fresh fruit, the margin between the on-tree and FOB price was found to increase with advances in the price level. The year was also included in the equation for the price of fruit for processing.

The packs of canned sections and frozen concentrated juice were hypothesized to be a function of the FOB price of the product and the FOB price of the other two products that compete for the fruit, as well as the inventory level of the product and the USDA estimate of the size of the grapefruit crop for the year. The year was included to capture the effects of the emergence and decline of frozen concentrated juice and canned sections, respectively. Included in each equation were price expectation relationships consisting of the USDA crop estimate (to reflect expected supply) and the FOB price of the product (to reflect expected demand). The results did not indicate that expected prices influence pack decisions.

The storage equations also contained expected price relationships. Generally, the results did not indicate that expected prices influence storage decisions. Not surprisingly, the quantity of each of the products that was packed was found to affect the storage of the products in Model I. Also, the equations included the year and the USDA estimate. In Model II there was no pack, so the pack variables were omitted.

In Model I, the FOB demand for each of the products was estimated with the quantity of a product demanded as a function of its FOB price, the prices of substitutes, disposable personal income per capita, the FOB quantity in the previous month and the month. In Model II, the month variable dropped out because it covered such a short period of time. Seasonality in the demand for the products was found to exist. Also, generally, income had a positive effect on demand. With the exception of frozen concentrated juice, the own-price slopes were negative. It was suggested that the positive own-price slope for concentrated juice resulted from an identification problem.

The estimates of the structural coefficients, average prices and average quantities were used to calculate price elasticities. Also, measures of average disposable personal income per capita were used to calculate income elasticities. For Model I, the price elasticities of demand obtained at the FOB level were -0.392 for single-strength juice, -2.101 for canned sections, 0.163 for frozen concentrated juice and -12.268 for fresh grapefruit. The income elasticities for the first two products listed above were positive, while they were negative for the other two products. Based on the cross elasticities, single-strength juice and frozen concentrated juice were found to be substitutes. Cross elasticities for single-strength juice and concentrated grapefruit juice with respect to frozen concentrated orange juice were -0.268 and -0.622, respectively. For Model II, the demand elasticities were -1.254, -2.636 and -2.096 for single-strength juice, canned sections and frozen concentrated juice, respectively. The income elasticities for the products were all positive. Cross elasticities indicated that single-strength juice and frozen concentrated grapefruit juice were substitutes.

Direct and derived reduced form estimates were obtained for the two models. Implications of the derived reduced form estimates were discussed.

Finally, predictions were obtained for each of the models using both the estimated and derived reduced forms. Predictions were made for December, 1971, to March, 1972, for Model I and for August and September, 1971, for Model II. Model I predictions were evaluated using Theil's inequality coefficients. The reduced form estimated directly produced more accurate predictions that did the derived reduced form estimates. Because there were only two data points, the predictions for Model II were not evaluated. Based on observations, however, the derived reduced form estimates appeared to give more accurate predictions that did the reduced form estimated directly. Also, the predictions for Model II appeared to be considerably more accurate than those for Model I.

Conclusions

Based on the results obtained in the study, the following conclusions were drawn.

(1) During periods of rising disposable personal income per capita, such as has occurred in the years included in the study, both growers and processors experience increased returns through increases in prices and sales.

(2) Efforts on the part of producers to increase inventory levels would result in a decrease in net revenue during the months of Model I. However, during the months of Model II, declines in prices would be more than offset by an increase in sales, resulting in increased net revenues.

(3) Where frozen concentrated orange juice had been hypothesized to be a substitute for canned single-strength grapefruit juice and canned grapefruit sections, this was not found to be the case. Among grapefruit products, evidence of a substitution effect was found only for canned single-strength juice and frozen canned grapefruit juice.

(4) The Florida grapefruit industry is adversely affected by competition from Texas grapefruit. However, Texas grapefruit accounts for only a small percentage of the total grapefruit supply.

(5) As hypothesized, the seasonality in the harvest pattern of grapefruit has definite effects on prices and quantities at all levels.

(6) Price was shown to be an important consideration in pack and storage decisions. The signs of the coefficients indicate that current prices have a greater effect on inventory levels than do expected prices, where expected prices are measured in terms of current prices and crop estimates.

Suggestions for Further Research

There are several areas of further research that are suggested by the results of this study, the most obvious being further work on unsatisfactory coefficients in the structural models. As the models are refined, improved predictions should be obtained.

The calculated elasticities were different enough to suggest that some form of reallocation, among both product forms and the months of Models I and II, may benefit the industry. In order to investigate this possibility, more information on the costs of both production and storage for the various products are needed.

While predictions for some variables (pack of single-strength juice, pack of canned sections, etc.) were consistently above the actual values, predictions for other variables (pack of frozen concentrated juice, FOB price of single-strength juice, etc.) were consistently below the actual values. This may be due to inaccuracies in the models. However, this condition may also be due to changes in the structural relationships within the industry. The models in this study were essentially static in nature. To provide more information to the industry, the two models need to be linked together and made into one dynamic model that would allow for structural changes within the industry, including the emergence of new grapefruit products.

Finally, the retail sector is in need of further research. That sector received very little treatment in this study because of the lack of retail data.

APPENDIX

TABLES 9-21

Table 9. On-Tree and FOB Prices: Monthly Data Used in Estimating the Structural Models, 1964-71[a]

Year	Month	On-Tree Price Processing[b]	On-Tree Price Fresh Use[c]	FOB Price CSSGJ[d]	FOB Price CGS[e]
1964	July	--	--	--	--
	Aug.	--	--	5.36	4.74
	Sept.	--	--	5.32	4.70
	Nov.	--	--	--	--
	Dec.	1.04	2.54	3.67	4.61
1965	Jan.	.98	2.11	3.49	4.59
	Feb.	.59	1.86	3.09	4.59
	March	.57	1.45	2.78	4.68
	June	--	--	--	--
	July	--	--	4.11	4.72
	Aug.	--	--	4.11	4.61
	Sept.	--	--	4.02	4.51
	Nov.	--	--	--	--
	Dec.	.72	1.63	3.49	4.12
1966	Jan.	.82	1.78	3.63	4.32
	Feb.	.89	1.78	3.82	4.41
	March	.84	2.10	3.64	4.43
	June	--	--	--	--
	July	--	--	2.85	4.18
	Aug.	--	--	2.93	4.12
	Sept.	--	--	3.09	4.28
	Nov.	--	--	--	--
	Dec.	.32	1.31	3.07	4.31
1967	Jan.	.36	1.33	2.96	4.43
	Feb.	.32	1.26	2.89	4.51
	March	.28	1.04	2.85	4.54
	April	.24	.81	2.73	4.46
	July	--	--	--	--
	Aug.	--	--	2.75	4.49
	Sept.	--	--	2.96	4.55
	Nov.	--	--	--	--
	Dec.	.98	3.05	3.78	5.04
1968	Jan.	1.05	3.15	3.98	5.23
	Feb.	1.08	3.28	4.07	5.26
	March	1.11	3.44	4.05	5.34
	July	--	--	--	--
	Aug.	--	--	3.90	5.23
	Sept.	--	--	3.90	5.15
	Nov.	--	--	--	--
	Dec.	.36	1.86	3.28	4.74

Table 9. (continued)

Year	Month	On-Tree Price Processing[b]	On-Tree Price Fresh Use[c]	FOB Price CSSGJ[d]	FOB Price CGSE[e]
1969	Jan.	.36	1.86	3.24	5.01
	Feb.	.32	1.32	3.20	5.08
	March	.31	1.31	3.03	5.10
	April	.30	1.18	2.74	5.23
	July	--	--	--	--
	Aug.	--	--	3.28	4.99
	Sept.	--	--	3.28	5.07
	Nov.	--	--	--	--
	Dec.	.66	1.88	3.32	4.74
1970	Jan.	1.01	2.09	3.53	4.58
	Feb.	1.09	2.15	3.75	4.69
	March	1.11	1.50	3.84	4.61
	July	--	--	--	--
	Aug.	--	--	4.21	4.58
	Sept.	--	--	4.25	4.62
	Nov.	--	--	--	--
	Dec.	.98	1.49	4.49	4.63
1971	Jan.	.90	1.57	3.88	4.85
	Feb.	.92	2.11	3.72	4.65
	March	1.14	2.67	3.88	5.09

[a]All data are adjusted for the analysis (i.e., prices are deflated, appropriate quantities are converted to gallons single-strength equivalent, etc.).

[b]On-tree price of grapefruit for processing,deflated by Wholesale Price Index (dollars per 1 3/5-bushel box).

[c]On-tree price of grapefruit for fresh use, deflated by Wholesale Price Index (dollars per 1 3/5-bushel box).

[d]FOB price of canned single-strength grapefruit juice, deflated by Wholesale Price Index (dollars per case of twelve 46-ounce cans).

[e]FOB price of canned grapefruit sections, deflated by Wholesale Price Index (dollars per case of 24 number 303 cans).

Table 10. FOB Prices and Canned Single-Strength Grapefruit Juice Quantities: Monthly Data Used in Estimating the Structural Models, 1964-71[a]

Year	Month	FOB Price FCGJ[b]	FOB Price FG[c]	Pack CSSGJ[d]	Movement CSSGJ[e]	Inventory CSSGJ[f]
1964	July	--	--	--	1.951621	2.458738
	Aug.	4.19	--	--	0.912121	1.546617
	Sept.	4.14	--	--	0.995814	0.550803
	Nov.	--	--	--	2.192393	3.618592
	Dec.	4.06	--	4.896918	3.054382	5.461138
1965	Jan.	4.04	4.11	5.929856	2.470081	8.920896
	Feb.	3.28	4.11	4.013152	3.398386	9.535674
	March	3.34	4.08	6.712501	4.883637	11.364542
	June	--	--	--	3.898668	6.150290
	July	3.03	--	--	2.108170	4.042119
	Aug.	2.96	--	--	1.582180	2.459940
	Sept.	2.90	--	--	1.454524	1.005416
	Nov.	--	--	--	3.335030	3.642358
	Dec.	2.65	4.03	6.192044	4.561236	5.273155
1966	Jan.	2.78	4.50	7.087840	3.665382	8.695614
	Feb.	2.85	4.31	8.129761	3.697336	13.128041
	March	3.22	4.58	8.543817	3.416028	18.255843
	June	--	--	--	4.011262	13.655007
	July	3.04	--	--	3.449409	10.205598
	Aug.	2.93	--	--	3.790142	6.415456
	Sept.	3.04	--	--	2.727749	3.687707
	Nov.	--	--	--	2.698674	5.701446
	Dec.	3.24	3.82	4.813306	3.986331	6.528407
1967	Jan.	3.28	3.67	7.995478	5.057705	9.466178
	Feb.	2.56	3.46	7.285022	4.794070	11.957126
	March	2.50	3.47	11.803598	5.417958	18.342751
	April	2.62	3.21	10.507313	4.711892	24.138177
	July	--	--	--	3.738258	21.792203
	Aug.	2.64	--	--	5.193717	16.598493
	Sept.	2.68	--	--	4.338947	12.259546
	Nov.	--	--	--	3.185477	9.190451
	Dec.	3.29	5.50	3.370099	3.648879	8.911682
1968	Jan.	3.59	5.58	8.759892	5.196925	12.474646
	Feb.	3.36	5.69	7.853757	4.723333	15.605063
	March	3.41	5.85	8.318531	3.608646	20.314952
	July	--	--	--	3.695288	18.993285
	Aug.	3.69	--	--	3.993476	14.999810
	Sept.	3.80	--	--	2.650182	12.349628
	Nov.	--	--	--	3.068675	9.188356
	Dec.	3.64	4.24	2.740500	3.337847	8.591028

Table 10. (continued)

Year	Month	FOB Price FCGJ[b]	FOB Price FG[c]	Pack CSSGJ[d]	Movement CSSGJ[e]	Inventory CSSGJ[f]
1969	Jan.	3.61	3.86	4.929319	5.873912	7.646437
	Feb.	3.55	3.48	7.232981	6.001647	8.877765
	March	3.49	3.27	7.729567	4.678845	11.928481
	July	--	--	--	6.017855	13.790648
	Aug.	3.33	--	--	4.855062	8.935586
	Sept.	3.38	--	--	3.421902	5.513684
	Nov.	--	--	--	3.759794	4.712230
	Dec.	3.32	4.06	7.830073	6.446773	6.095533
1970	Jan.	3.29	4.27	8.802526	4.885489	10.012579
	Feb.	3.28	4.27	13.201101	6.636254	16.577424
	March	3.23	4.29	11.989734	5.455274	23.111886
	July	--	--	--	5.047026	10.326720
	Aug.	3.66	--	--	3.527665	6.799056
	Sept.	3.23	--	--	4.071813	2.727243
	Nov.	--	--	--	4.710116	8.879347
	Dec.	3.41	3.84	9.712046	6.247970	12.343413
1971	Jan.	3.39	3.98	11.146039	5.736052	17.753391
	Feb.	3.25	4.43	11.724024	5.899431	23.577985
	March	3.54	4.96	12.308719	7.430068	28.456630

[a] All data are adjusted for the analysis (i.e., prices are deflated, appropriate quantities are converted to gallons single-strength equivalent, etc.).

[b] FOB price of frozen concentrated grapefruit juice, deflated by Wholesale Price Index (dollars per case of twelve 6-ounce cans).

[c] FOB price of fresh grapefruit, deflated by Wholesale Price Index (dollars per 1 3/5-bushel box).

[d] Pack of canned single-strength grapefruit juice (million gallons).

[e] FOB movement of canned single-strength grapefruit juice (million gallons).

[f] Inventory of canned single-strength grapefruit juice at the end of the month (million gallons).

Table 11. Grapefruit Sections and Frozen Concentrated Grapefruit Juice Quantities: Monthly Data Used in Estimating the Structural Models, 1964-71[a]

Year	Month	Pack CGS[b]	Movement CGS[c]	Inventory CGS[d]	Pack FCGJ[e]	Movement FCGJ[f]
1964	July	--	1.022460	2.332324	--	0.561684
	Aug.	--	0.714680	1.617644	--	0.551097
	Sept.	--	0.836774	0.780870	--	0.506422
	Nov.	--	0.904075	2.909126	--	0.296036
	Dec.	3.562300	1.280197	5.191234	2.088287	1.076598
1965	Jan.	2.962998	1.079091	7.075132	1.491251	0.942372
	Feb.	1.400529	1.020142	7.455503	3.538407	1.714906
	March	0.667862	1.120976	7.002397	8.259516	2.182713
	June	--	1.180015	4.308339	--	1.874499
	July	--	0.861057	3.447282	--	1.330908
	Aug.	--	1.061778	2.385504	--	0.892482
	Sept.	--	1.132788	1.252716	--	1.219232
	Nov.	--	0.956151	3.776930	--	0.669060
	Dec.	3.361237	1.097347	6.040816	1.247259	1.039746
1966	Jan.	3.145638	1.797459	7.388989	1.218131	0.947149
	Feb.	2.160434	1.680165	7.869261	2.446513	1.324310
	March	0.480055	1.022210	7.327109	8.298927	2.555644
	June	--	1.209404	4.405418	--	1.248919
	July	--	0.946789	3.458629	--	0.359994
	Aug.	--	1.272125	2.186504	--	1.032990
	Sept.	--	0.888125	1.298379	--	0.839967
	Nov.	--	0.951078	3.769698	--	0.929120
	Dec.	3.399846	1.325639	5.843902	1.021913	0.501436
1967	Jan.	3.758712	2.218736	7.383884	0.727620	0.999089
	Feb.	2.888387	1.781474	8.490805	1.201764	1.017882
	March	1.526943	1.196833	8.820903	7.495006	1.773591
	April	0.234110	1.060047	7.994978	7.838528	2.362262
	July	--	0.781103	5.248297	--	0.670869
	Aug.	--	1.228119	4.020179	--	0.797529
	Sept.	--	0.998571	3.021607	--	0.626372
	Nov.	--	0.914247	4.128886	--	1.039956
	Dec.	2.651486	1.008619	5.771747	0.678044	0.892406
1968	Jan.	3.465165	2.171940	7.064968	0.716408	1.436037
	Feb.	1.757223	1.345358	7.476844	1.463166	0.836941
	March	0.478952	0.654908	7.300892	2.482589	1.683762
	July	--	1.030742	3.944072	--	1.069750
	Aug.	--	0.934619	3.009454	--	0.974437
	Sept.	--	0.859376	2.150078	--	0.818141
	Nov.	--	0.733249	2.103892	--	1.079200
	Dec.	2.447438	0.969281	3.612429	0.897783	0.895936

Table 11. (continued)

Year	Month	Pack CGS[b]	Movement CGS[c]	Inventory CGS[d]	Pack FCGJ[e]	Movement FCGJ[f]
1969	Jan.	2.810677	1.372105	5.050991	0.680096	1.471178
	Feb.	2.230290	1.503499	5.777787	1.428522	1.182990
	March	1.805284	1.500368	6.082704	6.509173	1.305443
	April	0.257659	0.720381	5.619977	8.639739	2.629807
	July	--	0.859302	3.537267	--	--
	Aug.	--	0.853305	2.683962	--	--
	Sept.	--	0.919684	1.764278	--	--
	Nov.	--	0.661507	3.618927	--	--
	Dec.	3.278489	0.881657	6.015755	1.250100	1.799625
1970	Jan.	2.478298	0.891095	7.602959	0.819228	1.431389
	Feb.	1.662063	0.896198	8.368826	3.564213	1.731246
	March	0.275356	0.730430	7.913748	7.467204	2.544918
	July	--	1.118499	4.440197	--	--
	Aug.	--	0.885016	3.555012	--	--
	Sept.	--	1.264434	2.290579	--	--
	Nov.	--	0.698051	3.737548	--	--
	Dec.	2.975326	0.996683	5.716136	2.296877	2.101504
1971	Jan.	2.774003	1.047219	7.442924	2.232781	1.779941
	Feb.	1.952298	1.773986	7.621221	3.591743	1.500689
	March	0.422967	1.251414	6.792779	13.474862	2.411083

[a]All data are adjusted for the analysis (i.e., prices are deflated, appropriate quantities are converted to gallons single-strength equivalent, etc.).

[b]Pack of canned grapefruit sections (million gallons single-strength).

[c]FOB movement of canned grapefruit sections (million gallons single-strength).

[d]Inventory of canned grapefruit sections at the end of the month (million gallons single-strength).

[e]Pack of frozen concentrated grapefruit juice (million gallons single-strength).

[f]FOB movement of frozen concentrated grapefruit juice (million gallons single-strength).

Table 12. Inventory of Frozen Concentrated Grapefruit Juice and Grapefruit Quantities: Monthly Data Used in Estimating the Structural Models, 1964-71[a]

Year	Month	Inventory FCGJ[b]	Grapefruit to Process[c]	Grapefruit to Pack[d]	Movement FG[e]
1964	July	3.944859	--	--	--
	Aug.	3.393762	--	--	--
	Sept.	2.887340	--	--	--
	Nov.	2.474318	--	--	--
	Dec.	3.486000	2.273478	1.233	5.698
1965	Jan.	4.034889	2.285966	1.903	8.882
	Feb.	5.85832	1.946810	1.868	8.770
	March	11.935601	3.435447	2.662	12.029
	June	6.788043	--	--	--
	July	5.457135	--	--	--
	Aug.	4.564654	--	--	--
	Sept.	3.345422	--	--	--
	Nov.	2.282657	--	--	--
	Dec.	2.490163	2.596718	1.730	7.870
1966	Jan.	2.761166	2.514622	1.897	8.675
	Feb.	3.883367	2.891151	1.369	6.206
	March	9.626648	4.172393	1.900	8.188
	June	7.242402	--	--	--
	July	6.882408	--	--	--
	Aug.	5.849418	--	--	--
	Sept.	5.009452	--	--	--
	Nov.	4.120631	--	--	--
	Dec.	4.641117	2.003511	1.627	7.546
1967	Jan.	4.369662	2.795418	1.806	8.434
	Feb.	4.553551	2.517126	1.713	7.959
	March	10.274959	4.676643	2.260	10.520
	April	15.751220	4.293357	1.878	8.472
	July	13.282481	--	--	--
	Aug.	12.484952	--	--	--
	Sept.	11.858579	--	--	--
	Nov.	11.744602	--	--	--
	Dec.	11.530246	1.490962	1.632	7.548
1968	Jan.	10.810615	2.873277	1.833	8.483
	Feb.	11.436846	2.470169	1.536	7.126
	March	12.235669	2.544530	1.963	8.948
	July	7.037550	--	--	--
	Aug.	6.063113	--	--	--
	Sept.	5.244973	--	--	--
	Nov.	4.374356	--	--	--
	Dec.	4.376215	1.487612	1.406	6.195

Table 12. (continued)

Year	Month	Inventory FCGJ[b]	Grapefruit to Process[c]	Grapefruit to Pack[d]	Movement FG[e]
1969	Jan.	3.585138	2.052868	1.553	6.834
	Feb.	3.830662	2.686540	1.626	7.049
	March	9.034390	4.055009	1.984	8.542
	April	15.044327	4.892301	1.429	6.108
	July	--	--	--	--
	Aug.	--	--	--	--
	Sept.	--	--	--	--
	Nov.	6.598702	--	--	--
	Dec.	6.049188	2.727343	1.609	7.438
1970	Jan.	5.437021	2.669758	1.578	7.346
	Feb.	7.269983	4.216797	1.690	7.748
	March	12.192275	4.216799	1.860	8.238
	July	--	--	--	--
	Aug.	--	--	--	--
	Sept.	--	--	--	--
	Nov.	5.300418	--	--	--
	Dec.	5.495797	3.198240	1.645	7.684
1971	Jan.	5.948630	3.565128	1.731	7.919
	Feb.	8.039700	3.761902	1.747	8.254
	March	9.103473	6.192047	2.082	8.954

[a]All data are adjusted for the analysis (i.e., prices are deflated, appropriate quantities are converted to gallons single-strength equivalent, etc.).

[b]Inventory of frozen concentrated grapefruit juice at the end of the month (million gallons single-strength).

[c]Quantity of grapefruit moving from the growers to the processors (million 1 3/5-bushel boxes).

[d]Quantity of grapefruit moving from the growers to the packers for fresh use (million 1 3/5-bushel boxes).

[e]FOB movement of fresh grapefruit (million gallons single-strength).

Table 13. Exogenous Variables: Monthly Data Used in Estimating the Structural Models, 1964-71[a]

Year	Month	Income[b]	Month[c]	Month Squared[d]	Season[e]	Texas Grapefruit[f]	Crop Size[g]
1964	July	--	--	--	--	--	--
	Aug.	2.131	2	4	0	--	26.3
	Sept.	2.138	3	9	0	--	26.3
	Nov.	--	--	--	--	--	--
	Dec.	2.172	3	9	2	0.490	31.5
1965	Jan.	2.156	4	16	2	0.628	31.5
	Feb.	2.157	5	25	2	0.367	31.5
	March	2.170	6	36	2	0.196	31.5
	June	--	--	--	--	--	--
	July	2.209	1	1	1	--	31.9
	Aug.	2.224	2	4	1	--	31.9
	Sept.	2.289	3	9	1	--	31.9
	Nov.	--	--	--	--	--	--
	Dec.	2.287	3	9	3	0.653	34.0
1966	Jan.	2.277	4	16	3	0.726	35.0
	Feb.	2.286	5	25	3	0.891	35.0
	March	2.299	6	36	3	1.037	34.0
	June	--	--	--	--	--	--
	July	2.294	1	1	2	--	34.9
	Aug.	2.298	2	4	2	--	34.9
	Sept.	2.309	3	9	2	--	34.9
	Nov.	--	--	--	--	--	--
	Dec.	2.326	3	9	4	0.868	39.5
1967	Jan.	2.339	4	16	4	1.042	39.5
	Feb.	2.346	5	25	4	0.889	39.5
	March	2.354	6	36	4	1.356	39.5
	April	2.352	7	49	4	0.911	41.0
	July	--	--	--	--	--	--
	Aug.	2.363	2	4	3	--	43.9
	Sept.	2.369	3	9	3	--	43.9
	Nov.	--	--	--	--	--	--
	Dec.	2.39	3	9	5	0.602	32.5
1968	Jan.	2.382	4	16	5	0.585	32.5
	Feb.	2.407	5	25	5	0.647	32.5
	March	2.424	6	36	5	0.296	32.5
	July	--	--	--	--	--	--
	Aug.	2.412	2	4	4	--	32.9
	Sept.	2.426	3	9	4	--	32.9
	Nov.	--	--	--	--	--	--
	Dec.	2.438	3	9	6	0.787	42.0

Table 13. (continued)

Year	Month	Income[b]	Month[c]	Month Squared[d]	Season[e]	Texas Grapefruit[f]	Crop Size[g]
1969	Jan.	2.410	4	16	6	1.388	42.0
	Feb.	2.419	5	25	6	1.274	43.5
	March	2.425	6	36	6	1.300	43.5
	April	2.409	7	49	6	1.066	43.5
	July	--	--	--	--	--	--
	Aug.	2.449	2	4	5	--	39.9
	Sept.	2.452	3	9	5	--	39.9
	Nov.	--	--	--	--	--	--
	Dec.	2.441	3	9	7	1.068	37.0
1970	Jan.	2.453	4	16	7	1.668	37.0
	Feb.	2.452	5	25	7	1.382	37.0
	March	2.460	6	36	7	1.420	36.0
	July	--	--	--	--	--	--
	Aug.	2.459	2	4	6	--	37.4
	Sept.	2.464	3	9	6	--	37.4
	Nov.	--	--	--	--	--	--
	Dec.	2.439	3	9	8	1.520	49.0
1971	Jan.	2.475	4	16	8	1.773	47.0
	Feb.	2.480	5	25	8	1.671	43.0
	March	2.492	6	36	8	2.028	41.0

[a]All data are adjusted for the analysis (i.e., prices are deflated, appropriate quantities are converted to gallons single-strength equivalent, etc.).

[b]Disposable personal income per capita, deflated by Consumer Price Index (thousands of dollars).

[c]Month of the season.

[d]Month of the season squared.

[e]Crop season.

[f]Quantity of Texas grapefruit shipped (million boxes).

[g]From December through April, the USDA estimate of the size of the grapefruit crop for the year. From July through September, the actual size of the crop (million boxes).

Table 14. Retail Price of Frozen Concentrated Orange Juice and Demand Shifters: Monthly Data Used in Estimating the Structural Models, 1964-71[a]

Year	Month	Retail Price FCOJ[b]	Shifter CGS[c]	Shifter FCGJ[d]	Shifter FG[e]
1964	July	--	-	-	-
	Aug.	23.7	-	-	-
	Sept.	23.4	-	-	-
	Nov.	--	-	-	-
	Dec.	22.9	0	0	0
1965	Jan.	20.9	0	0	0
	Feb.	19.6	0	0	0
	March	19.4	0	0	0
	June	--	-	-	-
	July	16.2	-	-	-
	Aug.	16.1	-	-	-
	Sept.	15.8	-	-	-
	Nov.	--	-	-	-
	Dec.	15.8	0	1	0
1966	Jan.	15.1	0	1	0
	Feb.	15.3	0	1	0
	March	15.9	0	1	0
	June	--	-	-	-
	July	16.8	-	-	-
	Aug.	16.8	-	-	-
	Sept.	16.7	-	-	-
	Nov.	--	-	-	-
	Dec.	16.3	0	1	0
1967	Jan.	14.0	0	1	0
	Feb.	12.6	0	1	0
	March	12.5	0	1	0
	April	11.0	0	1	0
	July	--	-	-	-
	Aug.	12.3	-	-	-
	Sept.	12.3	-	-	-
	Nov.	--	-	-	-
	Dec.	13.4	1	0	1
1968	Jan.	14.1	1	0	1
	Feb.	14.3	1	0	1
	March	15.2	1	0	1
	July	--	-	-	-
	Aug.	14.9	-	-	-
	Sept.	15.2	-	-	-
	Nov.	--	-	-	-
	Dec.	15.8	1	0	0

Table 14. (continued)

Year	Month	Retail Price FCOJ[b]	Shifter CGS[c]	Shifter FCGJ[d]	Shifter FG[e]
1969	Jan.	15.9	1	0	0
	Feb.	16.5	1	0	0
	March	17.0	1	0	0
	April	17.2	1	0	0
	July	--	-	-	-
	Aug.	15.5	-	-	-
	Sept.	15.4	-	-	-
	Nov.	--	-	-	-
	Dec.	15.1	0	0	0
1970	Jan.	14.6	0	0	0
	Feb.	14.5	0	0	0
	March	13.7	0	0	0
	July	--	-	-	-
	Aug.	12.8	-	-	-
	Sept.	12.6	-	-	-
	Nov.	--	-	-	-
	Dec.	11.8	0	0	0
1971	Jan.	11.8	0	0	0
	Feb.	12.9	0	0	0
	March	12.4	0	0	0

[a]All data are adjusted for the analysis (i.e., prices are deflated, appropriate quantities are converted to gallons single-strength equivalent, etc.).

[b]Retail price of frozen concentrated orange juice, deflated by Consumer Price Index (cents per 6-ounce can).

[c]Intercept shifter for canned grapefruit sections FOB demand.

[d]Intercept shifter for frozen concentrated grapefruit juice FOB demand.

[e]Intercept shifter for fresh grapefruit FOB demand.

Table 15. Coefficients, Standard Errors and Coefficients of Determination of Reduced Form Equations from First Stage of Two-Stage Least Squares, Model I

	Endogenous Variable[a]					
	PGR		PGK		PFCS	
Exogenous Variable[a]	Coeff.	Standard Error	Coeff.	Standard Error	Coeff.	Standard Error
IN	-5.449	3.247	-1.659	6.446	-13.490	4.768
BCS	0.013	0.027	0.055	0.041	0.041	0.030
BCG	0.192	0.223	-0.021	0.442	-0.031	0.327
BFC	-0.045	0.058	-0.001	0.107	-0.198	0.079
m	-0.598	0.102	0.633	0.202	0.051	0.149
m^2	0.031	0.859	-0.082	1.705	-0.006	1.261
s	0.298	0.072	0.191	0.142	0.746	0.105
TG	-0.011	0.206	0.247	0.408	-0.127	0.302
POJ	0.010	0.202	0.068	0.401	-0.089	0.297
GE	-0.043	0.055	-0.103	0.108	-0.025	0.080
D1	0.150	0.027	0.414	0.054	-0.279	0.040
D2	0.099	1.436	0.293	2.851	0.328	2.109
D3	0.670	0.308	0.944	0.611	2.570	0.452
QFCS[b]	0.090	0.330	-0.012	0.654	0.072	0.484
QFCG[b]	-0.165	0.276	-0.122	0.549	-0.285	0.406
QFFC[b]	-0.093	0.632	-0.151	1.255	-0.092	0.929
GR	0.116	0.052	0.078	0.103	0.132	0.076
GK	1.613	0.120	-0.233	0.238	2.560	0.176
QFFG	-0.433	0.126	-0.014	0.251	-0.712	0.186
Constant	14.610	7.243	6.268	14.380	35.480	10.640
R^2	.94		.94		.93	

Table 15. (continued)

	Endogenous Variable[a]					
	PFCG		PFFC		PFFG	
Exogenous Variable[a]	Coeff.	Standard Error	Coeff.	Standard Error	Coeff.	Standard Error
IN	-0.552	2.015	1.673	3.634	-0.1087	6.075
BCS	0.006	0.013	0.037	0.023	0.057	0.039
BCG	-0.276	0.138	0.041	0.249	0.320	0.416
BFC	0.018	0.033	0.128	0.060	0.012	0.101
m	1.459	0.063	0.951	0.114	-0.536	0.190
m^2	-0.118	0.533	-0.139	0.961	-0.013	1.607
s	0.020	0.044	-0.191	0.080	0.101	0.134
TG	0.010	0.128	0.151	0.230	-0.181	0.385
POJ	-0.014	0.126	0.191	0.226	0.113	0.378
GE	0.017	0.034	0.090	0.061	-0.084	0.102
D1	-0.200	0.017	-0.349	0.031	0.684	0.051
D2	-0.214	0.891	-0.314	1.607	0.375	2.687
D3	0.756	0.191	0.252	0.344	0.698	0.575
QFCS[b]	-0.019	0.205	0.000	0.369	0.032	0.617
QFCG[b]	0.033	0.172	-0.092	0.309	-0.233	0.517
QFFC[b]	0.037	0.392	-0.076	0.708	-0.128	1.183
GR	0.088	0.032	0.1376	0.058	0.157	0.097
GK	-0.485	0.074	2.570	0.134	2.227	0.225
QFFG	0.093	0.078	-0.579	0.141	-0.556	0.236
Constant	2.795	4.496	-8.648	-8.108	5.724	13.550
R^2	.97		.94		.95	

Table 15. (continued)

Exogenous Variable[a]	Endogenous Variable[a] QPCS Coeff.	QPCS Standard Error	QFCS,SUCS Coeff.	QFCS,SUCS Standard Error	SCS Coeff.	SCS Standard Error
IN	-9.018	18.370	-18.670	16.670	9.445	27.480
BCS	-0.039	0.117	-0.055	0.106	1.015	0.175
BCG	-0.717	1.259	-1.934	1.142	1.217	1.883
BFC	-0.069	0.304	0.186	0.276	-0.255	0.455
m	8.549	0.574	10.740	5.210	-2.188	0.859
m^2	-0.808	4.858	-0.904	4.409	0.096	7.268
s	0.585	0.405	1.267	0.368	-0.682	0.606
TG	-1.594	1.164	-0.928	1.056	-0.666	1.742
POJ	-0.217	1.144	-0.466	1.038	0.250	1.711
GE	0.110	0.308	-0.102	0.280	0.212	0.461
D1	-1.408	0.155	-0.896	0.141	-0.512	0.232
D2	0.878	8.123	1.250	7.372	-0.372	12.150
D3	3.239	1.740	-0.215	1.579	3.454	2.603
QFCS[b]	0.198	1.865	-0.177	1.693	0.375	2.790
QFCG[b]	-1.390	1.564	-0.454	1.419	-0.936	2.340
QFFC[b]	0.569	3.577	0.198	3.246	0.371	5.352
GR	3.249	0.294	1.246	0.267	2.003	0.440
GK	-19.220	0.679	-8.989	0.616	-10.230	1.016
QFFG	3.686	0.715	1.868	0.649	1.819	1.070
Constant	5.445	40.980	34.170	-37.190	-28.720	61.310
R^2	.97		.88		.99	

Table 15. (continued)

	Endogenous Variable[a]					
	PCG		QFCG,SUCG		SCG	
Exogenous Variable[a]	Coeff.	Standard Error	Coeff.	Standard Error	Coeff.	Standard Error
IN	1.754	7.018	6.913	6.903	4.832	5.626
BCS	-0.042	0.045	-0.029	0.044	-0.013	0.036
BCG	-0.498	0.481	0.338	0.473	0.174	0.386
BFC	0.195	0.116	0.280	0.114	-0.084	0.093
m	3.419	0.219	1.393	0.216	1.990	0.176
m^2	-0.413	1.856	-0.231	1.826	-0.180	1.488
s	-0.243	0.155	-0.421	0.152	0.160	0.124
TG	-0.372	0.445	-0.566	0.437	0.182	0.356
POJ	0.049	0.437	0.152	0.430	-0.102	0.350
GE	0.049	0.118	0.025	0.116	0.024	0.094
D1	-0.036	0.059	1.107	0.058	-1.132	0.048
D2	0.676	3.103	0.559	3.053	0.093	2.488
D3	-0.771	0.665	-2.603	0.654	1.792	0.533
QFCS[b]	0.247	0.713	0.143	0.701	0.104	0.571
QFCG[b]	0.292	0.597	0.252	0.588	0.043	0.479
QFFC[b]	-0.125	1.367	-0.352	1.344	0.227	1.096
GR	0.435	0.112	0.208	0.111	0.227	0.090
GK	-6.294	0.259	0.489	0.255	-6.762	0.208
QFFG	1.351	0.273	-0.088	0.269	1.434	0.219
Constant	-9.562	15.660	-21.810	15.400	11.600	12.550
R^2	.98		.81		.99	

Table 15. (continued)

	Endogenous Variable[a]					
	PFC		QFFC,SUFC		SFC	
Exogenous Variable[a]	Coeff.	Standard Error	Coeff.	Standard Error	Coeff.	Standard Error
IN	6.155	19.200	-14.700	7.630	20.850	22.210
BCS	0.141	0.122	-0.015	0.049	0.156	0.141
BCG	1.653	1.315	-0.246	0.523	1.900	1.522
BFC	-0.118	0.318	-0.086	0.126	0.968	0.368
m	-12.650	0.600	0.308	0.239	-12.950	0.694
m^2	1.205	5.077	0.050	2.018	1.155	5.874
s	-0.518	0.424	0.813	0.168	-1.331	0.490
TG	1.857	1.216	0.119	0.483	1.738	1.407
POJ	0.249	1.195	-0.231	0.475	0.480	1.383
GE	-0.035	0.322	-0.046	0.128	0.011	0.373
D1	1.178	0.162	-0.578	0.064	1.756	0.188
D2	-1.887	8.489	-0.070	3.374	-1.818	9.822
D3	-1.747	1.818	1.041	0.723	-2.788	2.104
QFCS[b]	-0.410	1.949	-0.211	0.775	-0.199	2.255
QFCG[b]	0.938	1.634	-0.178	0.650	1.116	1.891
QFFC[b]	-0.403	3.738	0.009	1.486	-0.412	4.325
GR	0.667	0.307	0.065	0.122	0.602	0.356
GK	20.810	0.709	3.175	0.282	17.630	0.821
QFFG	-3.946	0.747	-0.738	0.297	-3.208	0.864
Constant	1.740	42.830	38.270	17.020	-36.530	49.550
R^2	.98		.89		.98	

[a]Variables are as defined in Chapter II.

[b]Quantity is lagged one month.

Table 16. Endogenous Variables: Actual Values, Predicted Values Based on the Derived Reduced Form and Deviations, December, 1971, Through March, 1972

Variable[a]		Month			
		December	January	February	March
PGR ($/box)	Actual	.92	.93	.92	.88
	Predicted	2.89	2.61	.38	2.34
	Deviation[b]	-1.97	-1.68	.54	-1.46
PGK ($/box)	Actual	1.54	1.49	1.44	1.34
	Predicted	2.11	1.98	1.77	1.54
	Deviation	-.57	-.49	-.33	-.20
PFCS ($/case)	Actual	4.72	4.58	4.51	4.07
	Predicted	5.38	5.92	3.89	7.22
	Deviation	-.66	-.34	0.62	-3.15
PFCG ($/case)	Actual	5.46	5.30	5.37	5.41
	Predicted	6.08	5.64	4.74	5.54
	Deviation	-.62	-.34	.63	-.13
PFFC ($/case)	Actual	3.97	3.85	3.80	3.83
	Predicted	12.53	6.90	-1.24	-4.51
	Deviation	-8.56	-3.05	5.04	8.34
PFFG ($/box)	Actual	5.40	5.24	5.10	4.90
	Predicted	4.44	4.32	4.12	3.98
	Deviation	0.96	0.92	0.98	0.92
PCS (mil. gal.)	Actual	10.007	11.853	13.202	15.416
	Predicted	-3.401	5.831	18.991	32.971
	Deviation	13.409	6.022	-5.788	-17.556
QFCS, SUCS (mil. gal.)	Actual	5.494	5.087	4.978	6.728
	Predicted	8.966	6.416	3.892	0.713
	Deviation	-3.472	-1.329	1.087	6.015
SCS (mil. gal.)	Actual	10.511	17.277	25.501	34.188
	Predicted	-6.369	9.926	32.376	57.759
	Deviation	16.880	7.351	-6.875	-23.570
PCG (mil. gal.)	Actual	2.706	2.064	1.361	0.448
	Predicted	1.928	1.643	2.033	0.444
	Deviation	0.779	0.421	-0.672	0.004

Table 16. (continued)

Variable[a]		Month			
		December	January	February	March
QFCG, SUCG (mil. gal.)	Actual	0.935	0.824	0.978	0.948
	Predicted	-0.195	0.498	0.899	0.299
	Deviation	1.130	0.326	0.080	0.649
SCG (mil. gal.)	Actual	4.610	5.850	6.233	5.732
	Predicted	4.962	5.755	6.984	6.377
	Deviation	-0.351	0.095	-0.752	-0.645
PFC (mil. gal.)	Actual	4.528	3.495	4.043	13.891
	Predicted	14.606	7.424	-2.788	-3.274
	Deviation	-10.078	-3.929	6.830	17.165
QFFC, SUFC (mil. gal.)	Actual	2.248	1.265	1.389	2.867
	Predicted	2.368	2.285	1.095	2.349
	Deviation	-0.120	-1.020	0.294	0.518
SFC (mil. gal.)	Actual	6.871	9.102	11.756	22.779
	Predicted	16.829	12.011	5.219	6.133
	Deviation	-9.958	-2.909	6.537	16.647

[a]Variables are as defined in Chapter II.

[b]Actual values minus predicted value.

Table 17. Theil's Inequality Coefficients for Predicted Values of the Endogenous Variables, Based on Derived Reduced Form, December, 1971, Through March, 1972

Endogenous Variable[a]	U_1	U_2
PR	0.9884	54.0267
PK	0.9542	5.1265
PFCS	0.9911	7.4356
PFCG	0.9187	4.0685
PFFC	0.9904	76.5459
PFFG	0.7373	5.5778
PCS	0.7900	6.1102
QFCS, SUCS	0.9891	3.4752
SCS	0.5192	1.8648
PCG	0.2910	0.6009
QFCG, SUCG	0.7279	3.7957
SCG	0.3308	0.7157
PFC	0.9450	1.9045
QFFC, SUFC	0.4286	0.6636
SFC	0.9012	1.5680

[a]Variables are as defined in Chapter II.

Table 18. Data Used in Forecasting and Evaluating Model I, by Months, November, 1971, Through March, 1972[a]

	Month				
Variable[b]	November	December	January	February	March
IN	--	2.539	2.532	2.535	2.550
BCS	--	5.997917	10.511106	17.276566	25.500870
BCG	--	2.839363	4.610377	5.849742	6.232629
BFC	--	4.591167	6.871231	9.101563	11.755719
m	--	3	4	5	6
m^2	--	9	16	25	36
s	--	9	9	9	9
TG	--	1.775	1.773	1.788	1.841
POJ	--	14.1	14.2	14.2	14.1
GE	--	44.0	44.0	44.0	44.0
GR	--	3.356612	3.535049	3.994213	6.554868
GK	--	1.595	1.703	1.846	2.461
QFFG	--	7.567059	8.344401	8.944146	12.050994
Constant	--	1	1	1	1
D1	--	0	0	0	0
D2	--	0	0	0	0
PGR	--	.92	.93	.92	.88

Table 18. (continued)

Variable[b]	Month				
	November	December	January	February	March
PGK	--	1.54	1.49	1.44	1.34
PFCS	--	4.72	4.58	4.51	4.07
PFCG	--	5.46	5.30	5.37	5.41
PFFC	--	3.97	3.85	3.80	3.83
PFFG	--	5.40	5.24	5.10	4.90
PCS	--	10.007586	11.852673	13.202453	15.415528
QFCS	3.162772	5.494398	5.087208	4.978151	6.727941
SCS	--	10.511106	17.276566	25.500870	34.188446
PCG	--	2.706365	2.063512	1.361168	0.447667
QFCG	0.477535	0.935351	0.824148	0.978281	0.9488071
SCG	--	4.610377	5.849742	6.232629	5.732224
PFC	--	4.528224	3.494987	4.042899	13.890840
QFFC	1.049064	2.248159	1.264655	1.388743	2.867180
SFC	--	6.871231	9.101563	11.755719	22.779373

[a]All data are adjusted for the analysis (i.e., prices are deflated, appropriate quantities are converted to gallons single-strength equivalent, etc.).

[b]Variables are as defined in Chapter II.

Table 19. Coefficients, Standard Errors and Coefficients of Determination of Reduced Form Equations from First Stage of Two-Stage Least Squares, Model II

	Endogenous Variable[a]					
	PFCS		PFCG		PFFC	
Exogenous Variable[a]	Coeff.	Standard Error	Coeff.	Standard Error	Coeff.	Standard Error
IN	-1.2694	5.1744	-2.0743	2.0465	1.7898	3.8188
Q	-0.3026	0.0511	-0.2350	0.0202	-0.1337	0.0377
m	1.5905	0.3318	0.2795	0.1312	0.7485	0.2449
POJ	0.2544	0.1056	-0.0631	0.0418	0.2389	0.0779
PFCS[b]	-0.2741	0.1510	-0.1420	0.0597	0.0067	0.1115
QFCG[b]	4.3058	0.5291	0.5532	0.2093	0.4865	0.3905
QFFC[b]	0.2882	0.1704	0.0691	0.0674	0.1090	0.1258
s	0.4905	0.2527	0.3960	0.1000	0.1892	0.1865
BCS	-0.1225	0.0355	-0.0231	0.0140	-0.0156	0.0262
BCG	1.6093	0.4409	0.0722	0.1744	0.7179	0.3254
BFC	0.2698	0.0704	0.2804	0.0279	0.0735	0.0520
Constant	0.9837	14.6727	14.4809	5.8031	5.8480	10.8287
R^2	.96		.96		.94	

Table 19. (continued)

	Endogenous Variable[a]					
	QFCS, SUCS		QFCG, SUCG		QFFC, SUFC	
Exogenous Variable[a]	Coeff.	Standard Error	Coeff.	Standard Error	Coeff.	Standard Error
IN	-15.5637	17.4035	-0.3060	2.7199	-1.2589	8.1745
Q	0.3180	0.1720	0.0393	0.0269	-0.2176	0.0808
m	-1.7139	1.1159	-0.3039	0.1744	-0.8204	0.5242
POJ	-0.2749	0.3552	-0.0850	0.0555	-0.3029	0.1668
QFCS[b]	-0.1247	0.5080	-0.0174	0.0794	-0.0832	0.2386
QFCG[b]	-0.8620	1.7797	-0.5417	0.2781	0.1189	0.8359
QFFC[b]	-0.2495	0.5732	-0.2017	0.0896	-0.5619	0.2692
s	0.7753	0.8501	-0.0254	0.1329	0.4391	0.3993
BCS	0.2154	0.1194	0.0016	0.0187	-0.1170	0.0561
BCG	-1.8440	1.4829	-0.2261	0.2318	-0.6881	0.6965
BFC	-0.1677	0.2369	-0.0382	0.0370	0.3493	0.1113
Constant	41.5624	49.3496	4.3901	7.7126	18.6836	23.1796
R^2	.83		.73		.68	

Table 19. (continued)

Exogenous Variable[a]	Endogenous Variable[a]					
	SCS		SCG		SFC	
	Coeff.	Standard Error	Coeff.	Standard Error	Coeff.	Standard Error
IN	15.6026	17.4507	0.2999	2.7333	1.2845	8.2114
Q	-0.3180	0.1725	-0.0393	0.0270	0.2175	0.0812
m	1.7158	1.1190	0.3037	0.1753	0.8217	0.5265
POJ	0.2756	0.3562	0.0849	0.0558	0.3033	0.1676
QFCS[b]	0.1250	0.5094	0.0174	0.0798	0.0834	0.2397
QFCG[b]	0.8615	1.7845	0.5418	0.2795	-0.1192	0.8397
QFFC[b]	0.2498	0.5747	0.2016	0.0900	0.5621	0.2704
s	-0.7771	0.8524	0.0257	0.1335	-0.4402	0.4011
BCS	0.7845	0.1197	-0.0016	0.0187	0.1169	0.0563
BCG	1.8469	1.4870	1.2257	0.2329	0.6901	0.6997
BFC	0.1676	0.2375	0.0382	0.0372	0.6507	0.1118
Constant	-41.6729	49.4833	-4.3728	7.7506	-18.7554	23.2844
R^2	.99		.99		.99	

[a]Variables are as defined in Chapter II.

[b]Quantities are lagged one month.

Table 20. Endogenous Variables: Actual Values, Predicted Values Based on the Reduced Form Estimated Directly and Deviations, August and September, 1971

Variable[a]		Month August	September
PFCS ($/case)	Actual	4.51	4.68
	Predicted	2.88	3.62
	Deviation[b]	1.63	1.06
PFCG ($/case)	Actual	5.22	5.42
	Predicted	4.81	4.66
	Deviation	0.41	0.76
PFFC ($/case)	Actual	3.80	3.94
	Predicted	3.09	3.34
	Deviation	0.71	0.60
QFCS, SUCS (mil. gal.)	Actual	3.875	4.454
	Predicted	6.415	5.356
	Deviation	-2.540	-0.902
QFCG, SUCG (mil. gal.)	Actual	0.751	0.987
	Predicted	1.220	1.038
	Deviation	-0.469	-0.051
QFFC, SUFC (mil. gal.)	Actual	2.099	2.710
	Predicted	5.432	6.140
	Deviation	-3.333	-3.430
SCS (mil. gal.)	Actual	9.798	5.343
	Predicted	7.256	4.441
	Deviation	2.542	0.902
SCG (mil. gal.)	Actual	3.100	2.113
	Predicted	2.631	2.063
	Deviation	0.469	0.050
SFC (mil. gal.)	Actual	8.899	7.189
	Predicted	9.843	8.678
	Deviation	-0.944	-1.489

[a]Variables are as defined in Chapter II.

[b]Actual value minus predicted value.

Table 21. Data Used in Forecasting for Model II, by Months, July, August and September, 1971[a]

Variable[b]	Month		
	July	August	September
IN	--	2.515	2.524
Q	--	42.9	42.9
m	--	2	3
POJ	--	14.0	14.3
s	--	7	7
BCS	--	13.672375	9.797588
BCG	--	3.850605	3.100056
BFC	--	11.997768	9.898608
Constant	--	1	1
PFCS	--	4.51	4.68
PFCG	--	5.22	5.42
PFFC	--	3.80	3.94
PFCS	4.750201	3.874787	4.454160
PFCG	0.760175	0.750549	0.987026
QFFC	1.532292	2.099160	2.709796
SCS	--	9.797588	5.343428
SCG	--	3.100056	2.113030
SFC	--	8.898608	7.188812

[a]All data are adjusted for the analysis (i.e., prices are deflated, appropriate quantities are converted to gallons single-strength equivalent, etc.).

[b]Variables are as defined in Chapter II.

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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