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DEMAND FOR FLORIDA FRESH SPECIALTY CITRUS

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Demand for Florida Fresh Specialty Citrus*

Introduction

Specialty citrus is an important part of Florida's fresh citrus industry. Over the last five seasons, specialty citrus has accounted for about 11% of the quantity and 16% of the value of all Florida fresh citrus (excluding lemons and limes) sold at the FOB level (Table 1). The FOB specialty citrus price has been 30% to 50% higher than the average price for all fresh citrus.

The price for specialty citrus, like the price for any good in general, tends to be inversely related to quantity sold. A plot of real price against shipments for the overall specialty citrus category, for the last two decades, roughly suggests an inverse relationship (Figure 1). All of the shipments under 10 million 4/5-bushel cartons have occurred in the 1980's, with most of the higher shipment levels having occurred in the 1970's. The shipment level for the most recent observation, 1988-89, was 8.3 million 4/5-bushel cartons. The highest shipment levels were 15.6 and 15.5 million 4/5-bushel cartons in 1979-80 and 1975-76, respectively. Visually, prices do not appear to change greatly with the level of shipments, suggesting present shipment levels can be expanded without unduly reducing price. From the plot itself, however, it is difficult to determine very precisely the exact price-quantity relationship, if any. Estimating a price-quantity equation based on the data in Figure 1 might provide a better idea of the exact relationship, but dispersion of the

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plotted data suggests other factors may be important for describing demand. The purpose of this paper is to examine more closely the demand for Florida fresh specialty citrus. Demand equations for each of the major varieties of specialty citrus--Temples, tangelos, tangerines and honey tangerines--will be developed and estimated. To illustrate how the different demand factors in aggregate might affect prices, the equations will then be used to project prices.

Model

The demand for specialty citrus is analyzed on an annual basis. In any given season, quantity is treated as fixed and price is determined by market demand. Formally, demand can be written as

(1) $$p_s = f(q_s),$$

where p_s and q_s are the price and quantity, respectively, of a particular variety of specialty citrus. Temples, tangelos, tangerines (Robinson and Dancy) and honey tangerines are considered.

Equation (1) can be generalized to include the quantities of related products, population and consumer income, i.e.,

(2) $$p_s = f(q_s, q_o, q_f, n, x),$$

where q_o is the quantity of oranges, including other specialty citrus; q_f is the quantity of other fresh fruit; n is population; and x is consumer income. Since income and population tend to increase together over time, it is difficult to determine their individual effects. A common way to handle this problem is to assume that a doubling of (or proportionate increase in) income, population and the quantities q_s, q_o and q_f will leave price unchanged. In this case, equation (2) can be written as

(3)
$$p_s = f\left(\frac{q_s}{n}, \frac{q_o}{n}, \frac{q_f}{n}, \frac{x}{n}\right),$$

where quantities and income are now expressed in per capita terms.

Equation (3) is the general specification examined in this paper. For estimation purposes, a double logarithmic functional form was used, i.e.,

(4)
$$\log p_s = \beta_0 + \beta_1 \log\frac{q_s}{n} + \beta_2 \log \frac{q_o}{n} + \beta_3 \log \frac{q_f}{n} + \beta_4 \log \frac{x}{n},$$

where the β's are parameters to be estimated. (A linear equation was also estimated and yielded similar results.) The double logarithmic specification is convenient for analyzing demand in terms of percentage changes. For example, the percentage change in price given a percentage change in quantity of specialty citrus is

(5)
$$\frac{\partial \log p_s}{\partial \log q_s} = \frac{\partial p_s}{\partial q_s}\frac{q_s}{p_s} = \beta_1.$$

Expression (5) is known as the own-flexibility. Cross-flexibilities for q_o, q_f and an income flexibility are likewise

(6)
$$\frac{\partial \log p_s}{\partial \log q_o} = \beta_2, \frac{\partial \log p_s}{\partial \log q_f} = \beta_3, \frac{\partial \log p_s}{\partial \log x} = \beta_4,$$

respectively.

An additional simplification of equation (4) examined here concerns the income flexibility β_4. Assuming absence of money illusion (consumer decisions are based on real price and income levels, in contrast to nominal levels), a doubling of (or proportionate change in) income, given quantities and population are fixed, will result in a doubling of (or proportionate change in) prices, i.e., $\beta_4 = 1$.

Data

As virtually all Florida fresh specialty citrus is sold in the U.S. and Canada, the combined U.S.-Canadian market is analyzed in this study. The price (p_s) and quantity (q_s) data for the different varieties of specialty citrus were taken from the Citrus Administrative Committee's (CAC's) *Annual Statistical Report* for various seasons. U.S. per capita consumption data for different fresh fruit compiled by the United States Department of Agriculture (USDA) were used in the construction of $\frac{q_o}{n}$ and $\frac{q_f}{n}$. Population and income data for the U.S. and Canada from the U.S. Department of Commerce and Agriculture Canada were used in the construction of per capita quantities $\frac{q_s}{n}$ and $\frac{q_o}{n}$, and per capita income $\frac{x}{n}$. The data on q_s from CAC are combined U.S. and Canadian shipments. Division of the latter data by the combined U.S. and Canadian population (n) yields $\frac{q_s}{n}$. USDA per capita consumption for oranges and other specialty citrus served as a basis to construct $\frac{q_o}{n}$. Consistently defined per capita consumption data for Canada were not available. As an approximation, Canadian per capita consumption of fresh fruit was assumed to be equal to U.S. per capita consumption of fresh fruit, and $\frac{q_o}{n}$ was constructed by subtracting $\frac{q_s}{n}$ from the USDA measure of U.S. per capita consumption of oranges and other specialty citrus. (The latter is a relatively minor adjustment but was made to avoid double counting; such double counting, in general, could result in a multicollinearity problem.) $\frac{q_f}{n}$ was measured directly by U.S. per capita consumption of other fresh fruit excluding oranges and other specialty citrus (as indicated in the USDA reference cited, $\frac{q_f}{n}$ includes apples, bananas, grapes, grapefruit, pears, peaches, and other types of fresh fruit). Finally, the per capita income variable $\frac{x}{n}$ was simply combined U.S. and Canadian disposable income divided by combined U.S. and Canadian population. The Canadian exchange rate was used to transform Canadian dollars into U.S. dollars in the latter calculation.

The time period analyzed was from 1970-71 to 1988-89, providing 19 observations.

Results

Model (4) was estimated for Temples, tangelos, tangerines and honey tangerines, using the seemingly unrelated regression (SUR) method. Several parameter restrictions were tested and found to hold. First, the hypothesis of no money illusion was tested using a chi-square test suggested by Gallant and Jorgenson. If money illusion is not present, there are four parameter restrictions--the parameter for the log of per capita income (β_4) is restricted to one in each of the four equations. The chi-square statistic for the test was 4.90 with four degrees of freedom (for the four restrictions) and indicated absence of money illusion at the $\alpha = .10$ level of significance, i.e., $\beta_4 = 1$ in each equation. The parameter for the log of per capita oranges and other specialty citrus in the equation for tangerines was also found to be insignificant with an incorrect sign (based on the expectation that tangerines and oranges and other specialty citrus are substitutes) and was restricted to zero.

The estimates of model (4) are shown in Table 2. The R^2's for the individual equations ranged from .94 for Temples to .98 for tangerines. All the estimated parameters were significant at the $\alpha = .10$ level of significance, except for the constant in the Temple equation and the parameter for oranges and other specialty citrus in the tangelo equation, the latter which was a borderline case being significant at the $\alpha = .11$ level. All the estimated parameters for the per capita quantity variables have negative signs as expected--a negative β_1 indicates the law of demand and negative β_2 and β_3 indicate substitute relationships, involving oranges and other specialty citrus, and other fresh fruit, respectively.

As discussed earlier, the coefficient estimates for the quantity variables are actually price flexibilities. The own-flexibility ranged from -.12 for Temples to -.52 for tangerines, indicating specialty citrus prices are relatively inflexible or insensitive to quantity shipped (an own-flexibility less than 1 in absolute value is considered inflexible; i.e., a one percent change in quantity results in less than a one percent change in price). The cross-flexibilities indicate various degrees of substitution. The Temple and tangerine prices are relatively sensitive to other fresh fruit shipments with -1.58 and -1.50 cross-flexibilities, respectively. The other cross-flexibilities range from -1.0 for other fresh fruit in the tangelo equation to -.41 for other fresh fruit in the honey tangerine equation, and for oranges and other specialty citrus in the tangelo equation.

A further analysis of the estimated relationships is provided in the following section.

Price Projections

For projecting prices, consider the total differentiation of equation (4), i.e.,

$$d \log p_s = \beta_1 d \log \frac{q_s}{n} + \beta_2 d \log \frac{q_o}{n} + \beta_3 d \log \frac{q_f}{n} + d \log \frac{x}{n}. \tag{7}$$

The general term $d \log x = \frac{dx}{x}$ is a measure of the percentage change in x; hence, equation (7) indicates the percentage change in the price of specialty citrus equals the sum of products between each flexibility and the corresponding percentage change in quantity, plus the percentage change in per capita income. For discrete changes over time, $d \log x$ can be approximated by the log change $\log x_t - \log x_{t-1} = \log \frac{x_t}{x_{t-1}}$ where subscript t indicates time.

An example illustrates the foregoing. Suppose that, over the next ten years, per capita quantities of tangelos; oranges and other specialty citrus; other fresh fruit; and per capita income grow, in terms of log changes, by 35%, 10%, 15%, and 50%, respectively. The nominal FOB tangelo price would then increase by 23% (= -.23 x 35% + -.41 x 10% + -1.00 x 15% + 50%). If the general price level, measured by the consumer price index (CPI), increases by 40%, again measured by the log change, then the real deflated price would decrease by 17% (the real price is $\frac{p_s}{CPI}$ and

$$\log \frac{p_{s,t}}{CPI_t} \Bigg| \frac{p_{s,t-1}}{CPI_{t-1}} = \log \frac{p_{st}}{p_{s,t-1}} - \log \frac{CPI_t}{CPI_{t-1}} = 23\% - 40\% = -17\%).$$

Accuracy in projecting prices depends on accuracy in projecting the per capita quantity and income variables themselves, as well as the accuracy of the flexibility estimates. The following assumptions about changes in the explanatory variables are made in projecting specialty citrus prices (all changes are in terms of log changes as before). First, based on trends in the last decade, nominal per capita income is assumed to grow by 6% per year. The CPI is assumed to grow by 5% per year; hence, real per capita income is assumed to grow by 1% per year. Also, based on trends in the last decade, per capita consumption of other fresh fruit is assumed to grow by 1.5% per year.

Growth in per capita orange and other specialty citrus consumption was assumed to be 1% per year. The latter citrus category is dominated by oranges, with Florida oranges accounting for 16% of the total in 1988-89. Based on projected increases in Florida orange production over the next ten years by the Florida Department of Citrus (FDOC), fresh Florida orange utilization could more than double. On the other hand, orange production in California and Arizona, the largest suppliers, is expected to be relatively flat in the upcoming years. Hence, total fresh orange shipments could go up by roughly 20% over the next ten years, or about 2% per year, on average. With population in the U.S. and Canada increasing at about 1% per year, per capita orange and other specialty citrus consumption is thus expected to grow by 1% per year. (Since specialty citrus accounts for a small part of the latter category, the growth rates for specialty citrus examined here will not have a significant effect on the assumption.)

For per capita specialty citrus, a range of growth rates was assumed. Citrus tree planting levels have been at record high levels in recent years. It is difficult, however, to project future planting rates and production growth, particularly for some of the different varieties of citrus. The growth in per capita specialty citrus shipments considered here ranges from a decrease of 10% per year to an increase of 10% per year. (Given population grows at 1% per year, the latter coincides with a range of -11% to 11% for growth in actual specialty citrus shipments.)

Projected specialty citrus real FOB price changes per year for alternative per capita shipment growth rates are given in Table 3. The projections suggest tangerine prices are most sensitive to shipment changes, while honey tangerine prices are least sensitive; e.g., a 10% increase in per capita shipments of tangerines (honey tangerines) is projected to decrease the tangerine (honey tangerine) real price by 6.5% (1.5%). As indicated in the table, a given percentage decrease in per capita shipments has a smaller effect (in absolute value) on price than a corresponding percentage increase in per capita shipments. The result is due to the assumed increases in the other explanatory variables which negatively affect price. In fact, for Temples, even a 10% decrease in per capita shipments still results in a .7% decrease in price due to the impact of the other explanatory variables; for the other varieties, decreases in shipments generally result in price increases. The projections assuming a zero growth rate in per capita specialty citrus shipments indicate the expected effect of the other factors, in aggregate. As the projections show, if per capita specialty citrus shipments remain unchanged, price is expected to decline due to increases in shipments of competing fruit; expected real income growth offsets the latter negative effect to a degree.

Price projections assuming 5% growth in actual specialty citrus shipments, as opposed to per capita shipments, were also made for the next ten years as shown in Table 4. The assumptions regarding the other explanatory variables were maintained as stated before. The 5% growth rate is not meant to be a "best guess;" 5% is considered a relatively high growth rate to sustain and is assumed, as present interest is on price impacts that might occur if expansion in the Florida citrus industry continues with a focus on specialty citrus.

The projections in Table 4 show tangerine, Temple, tangelo and honey tangerine real FOB prices decreasing by 29%, 21%, 17% and 6%, respectively, measured by dividing the absolute price change over the period by the initial prices in 1990-91, in contrast to log changes. The results suggest specialty citrus prices would not be hurt too greatly even if shipments increased at a relatively fast rate such as 5%. For interest in other shipment growth rates, ten-year projections can be made straightforwardly using Table 3, e.g., for Temples, 8% growth in per capita shipments (about 9% growth in actual shipments assuming 1% population growth) over the ten years results in a 28.8% price decrease in terms of the log change (10 x 2.88 in Table 3) and a 33.3% decrease found by dividing the absolute price change over the period by the initial price in 1990-91.

Concluding Comments

Analysis of specialty citrus shipment and price data for the last two decades suggests specialty citrus prices are relatively inflexible to shipment levels. The data also indicate shipments of competing fruit are important determinants of specialty citrus prices. Assuming relatively large increases in specialty citrus shipments and moderate increases in shipments of competing fruit, relatively moderate decreases in specialty citrus prices are projected.

TABLES

Table 1. Florida FOB fresh shipments, specialty citrus versus total citrus, 1985-86 through 1989-90.

Season	Specialty Citrus			Total Citrus			Percentage of Total		
	4/5-bu. cartons	$ Value	Price	4/5-bu. cartons	$ Value	Price	4/5-bu. cartons	$ Value	Price
	(000)	(000)	($/box)	(000)	(000)	($/box)	- - - - - - - % - - - - - - -		
1985-86	6,837	62,488	9.14	62,805	379,663	6.05	10.9	16.5	151.1
1986-87	7,673	66,003	8.60	65,877	424,874	6.45	11.6	15.5	133.3
1987-88	8,376	78,588	9.38	71,408	490,640	6.87	11.7	16.0	136.5
1988-89	7,381	74,316	10.07	69,104	452,012	6.54	10.7	16.4	154.0
1989-90	4,303	48,878	11.36	40,441	328,651	8.13	10.6	14.9	139.7

SOURCE: Citrus Administrative Committee, *Annual Statistical Report*, various seasons.

Table 2. Seemingly unrelated regression estimates of FOB demand for fresh specialty citrus, equation 4.

Variety of Specialty Citrus	Estimated Parameter (Flexibility)[a]			
	Constant	Specialty Citrus Shipments	Orange and Other Specialty Citrus Consumption	Other Fresh Fruit Consumption
	β_0	β_1	β_2	β_3
Temples	0.144	-0.124*	-0.637*	-1.503*
	(1.511)[b]	(0.065)	(0.339)	(0.282)
Tangelos	-3.118*	-0.234*	-0.409	-1.003*
	(1.301)	(0.104)	(0.238)	(0.259)
Tangerines	-2.622*	-0.516*		-1.582*
	(1.101)	(0.689)		(0.319)
Honey Tangerines	-4.631*	-0.139*	-0.478*	-0.406*
	(1.340)	(0.032)	(0.246)	(0.196)

[a] For all varieties, the income-flexibility β_4 is restricted to 1; for tangerines, the cross-flexibility with respect to orange and other specialty citrus consumption β_2 is restricted to 0.

[b] Estimated standard error in parentheses.

*Statistically different from zero at the α = .10 level of significance.

Table 3. Projected annual percentage real FOB price changes for specialty citrus, assuming alternative per capita shipment growth rates.[a]

Per Capita Shipment Growth Rate	Variety			
	Temples	Tangelos	Tangerines	Honey Tangerines
- % -	----------- percentage price change -----------			
-10	-0.65	1.42	3.79	1.31
-8	-0.90	0.96	2.76	1.03
-6	-1.15	0.49	1.73	0.75
-4	-1.40	0.02	0.69	0.47
-2	-1.64	-0.45	-0.34	0.19
0	-1.89	-0.91	-1.37	-0.09
2	-2.14	-1.38	-2.41	-0.36
4	-2.39	-1.85	-3.44	-0.64
6	-2.63	-2.32	-4.47	-0.92
8	-2.88	-2.78	-5.50	-1.20
10	-3.13	-3.25	-6.54	-1.48

[a] Also, assumes 6% growth in per capita income, 5% inflation, 1.0% growth in per capita consumption of oranges and other specialty citrus, and 1.5% growth in per capita consumption of other fresh fruit.

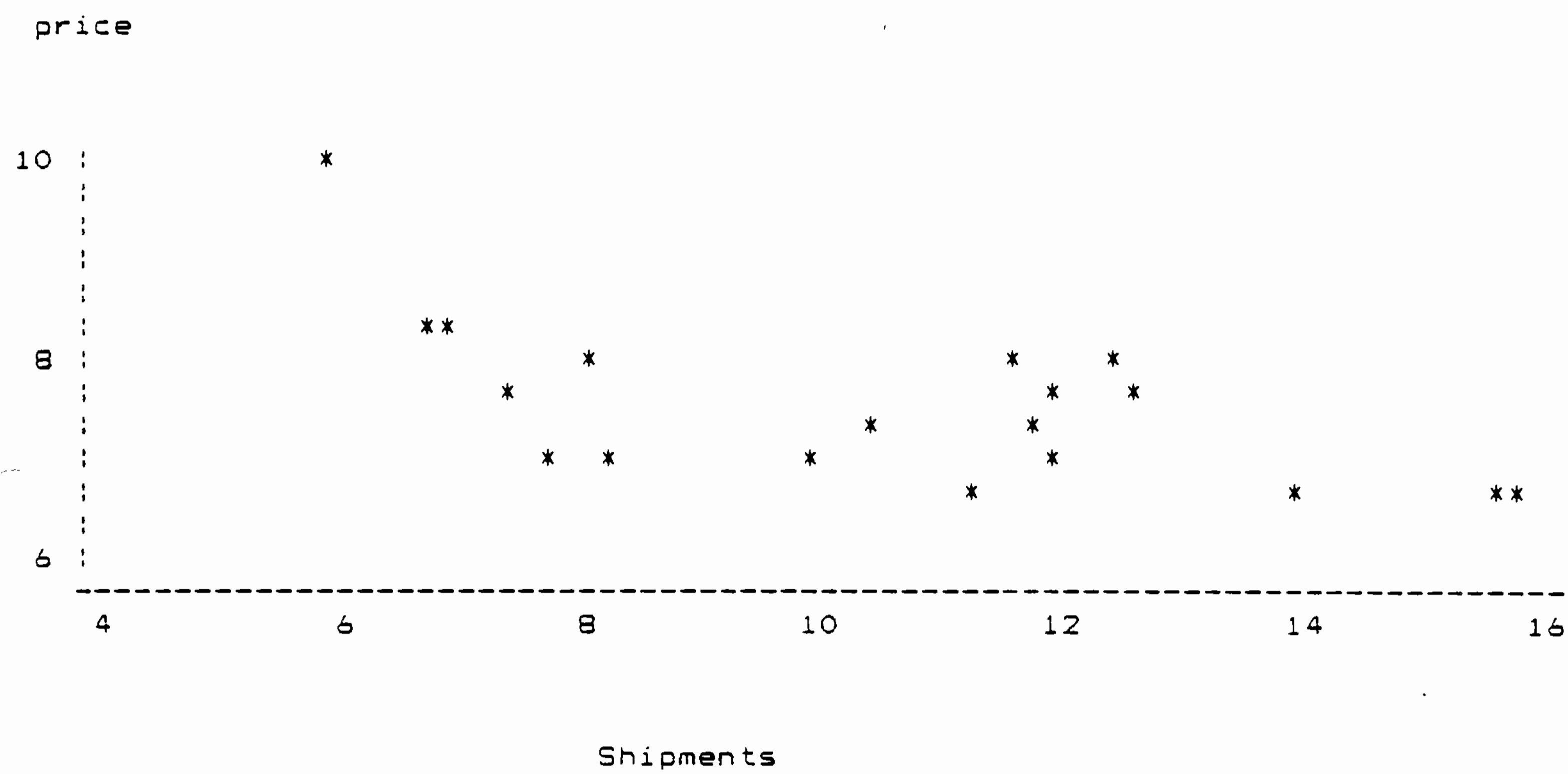
Table 4. Projected real FOB prices for specialty citrus, assuming 5% annual growth in shipments.[a]

Season	Variety			
	Temples	Tangelos	Tangerines	Honey Tangerines
	- - - - - - - - 1990-91 dollars per 4/5-bu. carton - - - - - - - -			
1990-91	7.90	8.75	18.19	14.57
1991-92	7.71	8.59	17.58	14.48
1992-93	7.53	8.43	16.98	14.38
1993-94	7.35	8.27	16.41	14.29
1994-95	7.18	8.12	15.85	14.20
1995-96	7.01	7.97	15.32	14.11
1996-97	6.84	7.83	14.80	14.02
1997-98	6.68	7.68	14.30	13.93
1998-99	6.52	7.54	13.82	13.84
1999-2000	6.37	7.41	13.35	13.75
2000-01	6.22	7.27	12.90	13.66

[a] Also, assumes 6% growth in per capita income, 5% inflation, 1.0% growth in per capita consumption of oranges and other specialty citrus, 1.5% growth in per capita consumption of other fresh fruit, and 1% growth in population..

FIGURE

Figure 1. Fresh Florida specialty citrus real FOB prices versus shipments, for 1970-71 through 1988-89, with price in 1982-84 dollars per 4/5 bushel cartons, and shipments in millions of 4/5 bushel cartons.



Source: Citrus Administration Committee, Annual Statistical Report, various seasons.

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