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PRODUCTION RESPONSES AND PRICE DETERMINATION IN THE FLORIDA WATERMELON INDUSTRY

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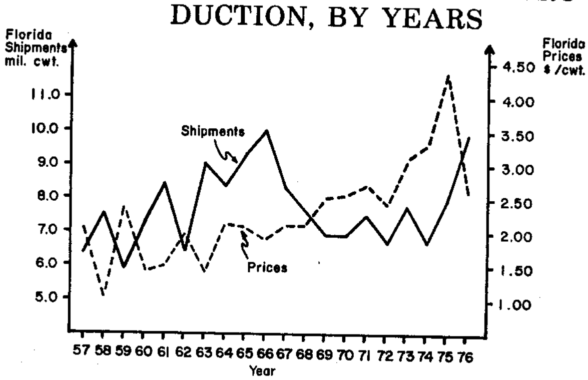
This article presents a model of the Florida watermelon industry that quantifies aggregate entry and exit decisions and the effect of inter-regional competition on prices received by Florida growers. The model development is presented first and is followed by estimation of the model's parameters. Policy implications from the model are then developed.

Florida is a major supplier of spring and summer watermelons for the domestic U. S. market. Total crop value for Florida during the 1976 season was well over $25 million which represented 4.9 percent of the total fresh vegetable income for the state that year. Florida's dominant position in the national watermelon market is illustrated by the fact that for the crop years 1972 through 1976 Florida provided more than 50 percent of total U. S. shipments during the seven-week period beginning the first week in April.

Market dominance, however, has not resulted in a profitable market, statewide, for Florida watermelon producers. Because of rapid entry and exit by producers in response to fluctuating prices, watermelon shipments in Florida have shown the cyclical pattern illustrated graphically in Figure 1. Generally, profitable seasons encourage entry and increased production in the following years which result in lower prices and depressed profit levels. In addition, though Florida markets the first domestically produced watermelons of the season, at correspondingly high prices, the average seasonal price for Florida is well below the season opening values. The average price for the state as a whole is generally below the price received in other competing southeastern states, partly because growers in panhandle, northern, and central areas of Florida compete directly with other southern producers who have a locational advantage in relation to major markets.

FIGURE 1. WATERMELON SHIPMENTS AND AVERAGE FOB PRICES FOR FLORIDA PRODUCTION, BY YEARS



Only the early production from the southern production areas of Florida is relatively free of domestic competition. However, in 1978 less than 10 percent of total harvested watermelon acreage in Florida was in the southern producing region (Table 1). The central producing area is subject to increasing levels of domestic competition as its harvest season progresses and the northern and western regions compete with other southeastern areas throughout their harvest season. The western or panhandle area growers planted nearly twice as many acres as the southern region but harvested only slightly more acreage because 4,500 acres were abandoned. Only 100 acres were abandoned in the southern area (Table 1).

TABLE 1. ACREAGE AND PRODUCTION BY AREAS, FLORIDA, 1978 CROP YEAR

Area	Acreage		Yield per acre	Production
	Planted	Harvested		
	- - - acres - - -		cwt	1,000 cwt
West	9,500	5,000	90	450
North	34,000	31,000	155	4,805
Central	10,700	9,300	191	1,777
South	4,800	4,700	206	968
State	59,000	50,000	160	8,000

Source: Florida Crop and Livestock Reporting Service.

MODEL

Each season Florida watermelon growers are faced with two sequential decisions. First, without knowledge of the price they will receive, growers decide how many acres to plant.

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Second, at time of harvest, growers determine how many acres to harvest given the observable current price. The current price depends on shipments which depend on how many acres growers decide to harvest.

Four equations and one definitional identity are used to describe growers' decisions and price determination process.

Number of acres planted is hypothesized to be related positively to prices received in previous seasons and negatively to a time trend. That is:

$$(1)\quad QP_t = \beta_{10} + \beta_{11}PF_{t-1} + \beta_{12}PF_{t-2} + ... + \beta_{1n}PF_{t-n} + \beta_{1n+1}T_t + e_{1t}$$

where

- QP_t is number of acres in Florida planted in watermelons in year t
- PF_{t-1}, PF_{t-2}, ..., PF_{t-n} are lagged prices ($/100 lbs) of Florida watermelons in year $t-1$, ..., $t-n$
- T_t is a time-trend variable, T=1 for 1953, 2 for 1954, ..., 24 for 1976
- e_{1t} is the disturbance term.

The lagged price coefficients capture the cobweb effect similar to that identified by Suits [3] and discussed by Waugh [4]. The time-trend coefficient expectation reflects the declining production trend that has been observed and attributed, in part, to increasing competition for land in Florida.

The length of the lag and the structure of the weights for the lagged price variables are difficult to specify *a priori*. The length of the lag should reflect the extent to which growers project past occurrences to the future. Parameter estimates and their associated standard errors for equation 1 are shown in Table 2. Three lagged price variables are included. The length of the lag was determined empirically by retaining lagged price variables as long as the coefficient is greater than its estimated standard error. The price variable parameters are not restricted to any particular weighing scheme although they are similar to estimates from a third-degree polynomial distributed lag.

The second behavioral relationship represents growers' harvest decisions. It is hypothesized that quantity harvested is positively related to quantity planted and price change from the previous year. It is further hypothesized that the effect of price on harvested acres depends on quantity planted and that the effect of quantity depends on price. If quantity planted is high, prices will induce additional harvesting. If quantity planted is low, prices will have very little impact on the harvesting decision. To capture these phenomena, quantity planted and price are interacted in the harvesting decision function. That is:

$$(2)\quad QH_t = \beta_{20} + \gamma_{21}(QP_t)(PF_t) + \gamma_{22}\Delta PF_t + e_{2t}$$

where

- QH_t is number of acres of Florida watermelons harvested in year t
- PF_t is price ($/100 lbs) of Florida watermelons in year t

TABLE 2. ESTIMATED COEFFICIENTS AND THEIR RESPECTIVE STANDARD ERRORS[a] FOR LINEAR FORM OF FLORIDA WATERMELON INDUSTRY MODEL, 1957 TO 1976 DATA

Equation	Endogenous Variables[b]						Predetermined Variables[b]						Constant
	QP_t	QH_t	QS_t	PF_t	$PF_t XQP_t$	ΔPF_t	PF_{t-1}	PF_{t-2}	PF_{t-3}	QO_t	YLD_t	T_t	
1	-1						16.6478 (8.2280)	16.9061 (8.8028)	9.8832 (8.0713)			-3.6273 (.7691)	34.0954 (24.7790)
2		-1			.5544 (.1537)	-16.946 (6.8032)							-7.4945 (18.9618)
3		86.6399 (24.8312)	-1								62.8952 (5.7095)	-57.8848 (38.7167)	-5104.99 (2527.3)
4			-.00017 (.00006)	-1						-.000011 (.000030)			4.8039 (.7085)
5				+1		-1	-1						

[a]Standard errors are presented in parentheses below the coefficients.

[b]Variable definitions:

QP_t, QH_t number of acres of watermelons planted and harvested in Florida in year t
QS_t thousands of hundredweight of watermelons shipped from Florida in year t
PF_t, PF_{t-1}, PF_{t-2}, PF_{t-3} current and prior year farm gate prices for Florida watermelons in year t in dollars per 100 lbs
$\Delta PF_t = PF - PF_{t-1}$ change in price from previous year
QO_t thousands of hundredweight of watermelons shipped from spring and early summer melon producing states (Alabama, Georgia, California (desert), South Carolina, Texas) in year t
YLD_t yield of watermelons in Florida in year t, 100 lbs per acre
T_t time trend, T = 1 for 1953, 2 for 1954, ... , 24 for 1976

ΔPF_t is $PF_t - PF_{t-1}$
QP_t is as defined previously
e_{2t} is the disturbance term.

The third equation simply recognizes the technical relationship among shipments, harvested acreage, yield, and factors associated with a time trend. That is:

$$(3)\quad QS_t = \beta_{30} + \beta_{31}QH_t + \beta_{31}YLD_t + \beta_{32}T_t + e_{3t}$$

where

QS_t is thousands of hundredweight of watermelons shipped from Florida in year t
YLD_t is yield (100 lbs/acre) of watermelons in Florida in year t
QH_t and T_t are as previously defined
e_{3t} is the disturbance term.

The final behavioral equation describes the price determination process. The price of Florida watermelons is hypothesized to be related negatively to quantity shipped from Florida and quantity shipped from other competing producing areas. That is:

$$(4)\quad PF_t = \beta_{40} + \gamma_{41}QS_t + \beta_{41}QO_t + e_{4t}$$

where

QO_t is quantity of watermelons shipped from Georgia, Alabama, South Carolina, Texas, and California (desert)
PF_t and QS_t are as defined previously
e_{4t} is the disturbance term.

Empirical parameter estimates and their associated standard errors are shown in Table 2 along with the identity defining ΔPF_t. Two-stage least squares (TSLS) was used to estimate the model's parameters. Note that acres planted in equation 1 is dependent only on predetermined variables which means that TSLS estimates of the parameters are equivalent to ordinary least squares parameter estimates. Equations 2, 3 and 4 along with the definitional identity capture the simultaneous harvest, shipping, and pricing functions. Current price has an impact on harvesting decisions and harvesting decisions have an impact on price through the shipments equation.

COEFFICIENT INTERPRETATION AND USE

The coefficients of the model address both the entry-exit issue and the interregional competition questions facing the Florida watermelon industry.

The model shows that the present season's plantings are partly determined by the previous season's prices. The duration of this effect is apparently three years; that is, high (low) prices in one year will continue to encourage (discourage) plantings for three years with the strongest effects coming the first two years after the high (low) prices. Prices in the two most recent seasons have the greatest effect on planting decisions. Lagged acreage response coefficients are calculated as:

$$(1)\quad \varepsilon_{R-1} = \frac{\partial QP_t}{\partial PF_{t-1}} \frac{\overline{PF}_{t-1}}{\overline{QP}_t} = 16.6478\,\frac{2.17}{60.45} = .60$$

$$(2)\quad \varepsilon_{R-2} = 16.7061\,\frac{2.17}{60.45} = .61$$

$$(3)\quad \varepsilon_{R-3} = 9.8832\,\frac{2.17}{60.45} = .35$$

Thus, a 10 percent increase (decrease) in price can be expected to result in a 6 percent increase (decrease) in planted acres the next two seasons and a 3.5 percent increase (decrease) the third season.

These results clearly demonstrate the cobweb phenomenon and the fact that through the harvest and price equations it becomes a source of cyclical price variability in the Florida watermelon industry. For individual producers, an understanding of the lag structure may allow greater use of countercyclical production decisions.

The coefficients related to the conclusions about interregional trade are the quantity coefficients from the fourth equation. Shipments from Florida have less effect on Florida prices than the shipments from competing states. Price flexibility values for Florida shipments and shipments from other states are calculated as:

$$(4)\quad F_1 = \frac{PF_t\,\overline{QS}_t}{QS_t\,\overline{PF}_t} = (-0.00017)\frac{7713.25}{2.17} = -.60$$

$$(5)\quad F_2 = \frac{PF_t\,\overline{QO}_t}{QO_t\,\overline{PF}_t} = (-0.00011)\,\frac{13791.00}{2.17} = -.70$$

Thus, a 1 percent increase in Florida shipments reduces Florida prices by .6 percent whereas a 1 percent increase in shipments from other states causes a price decline of .7 percent. In terms of an absolute change in quantity shipped from either region, the effect on Florida prices would be greater if that quantity came from Florida. Policy instruments designed to restrict Florida plantings systematically could effectively enhance prices only if production from other areas could also be curtailed.

The specification of the harvest equation means that the marginal propensity to harvest from planted acres is price dependent and that the effect of prices on harvest decisions depends on the level of plantings. That is:

$$(6) \quad \frac{\partial QH_t}{\partial QP_t} = .5544PF_t$$

$$(7) \quad \frac{\partial QH_t}{\partial PF_t} = -16.946 + .5544$$

If prices increase, the marginal propensity to harvest from planted acreage increases as indicated by equation 6. Equation 7 indicates that the marginal effect of price on acreage harvested increases with acreage planted. At planting levels below 30.6 thousand acres the price effect is zero ($\partial QH_t/\partial PF_t = 0$ if $QP_t = \frac{-16.946}{.5544}$). In general, $\partial QH_t/\partial PF_t$ is greater than zero at all QP_t observed. Both of these relationships conform to expectations.

CONCLUSIONS

The Florida watermelon industry is shown to exhibit cobweb-pattern planting decisions with prices for the three most recent seasons influencing growers' planting decisions. The two most recent prices have the greatest impact on planting decisions.

Florida prices are found to be related negatively to both Florida shipments and shipments from competing production regions. Approximately 91 percent of harvested acreage in Florida is subject to domestic competition from other southern producing states. Growers in these areas must consider both local and regional production in their formation of planting decisions.

REFERENCES

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