FLORIDA TOMATO MARKET ORDER RESTRICTIONS—AN ANALYSIS OF THEIR EFFECTS AND IMPLEMENTATION

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The Florida tomato industry produces about 90 percent of the domestic fresh tomato supplies during the November to mid-June season (Brooker and Pearson). Most of this supply is produced in an area under the authority of Federal Marketing Order 966 for fresh tomatoes. Federal marketing orders have been scrutinized in recent government studies and the USDA has been under pressure to justify the existence of these orders (USDA, AMS). Federal Marketing Order 966 uses quality restrictions to provide orderly market conditions for producers and consumers. This study measures the gains that producers could realize with quality restrictions and assesses the process for implementing these restrictions.

Price discussed the effect on revenue of restricting quantities of a product from the market. His results indicate that an optimum culling rate can be defined if the elasticity of demand and the quality price response are known. Defining the optimum culling rate with the Price procedure requires that the product be differentiated on a continuum of quality measures. Florida tomatoes, like most agricultural products, are segregated for marketing purposes within defined size and/or grade guidelines, giving a specified set of sizes and grades for the product. These grades and sizes are established prior to each season. Culling from this set of sizes and grades requires a specific size and/or grade to be excluded from the market, therefore not allowing a continuum of choices within a season. The approach used here to investigate the effects of quality restrictions on producers includes (1) development of a theoretical model for testing the effects of a restriction on specific sizes and/or grades; (2) estimation of a structural model for Florida tomatoes encompassing the factors from the theoretical model, and (3) measurement of the impacts of restrictions on producers via simulation procedures. The empirical model developed and used here for simulation purposes is similar to one proposed but not estimated by Montes. A model for prices received by growers for fresh tomatoes was formulated and estimated in order to measure the impacts of restrictions on growers. The impact of restrictions on shippers is then discussed and implications are drawn concerning the implementation of such restrictions.

MODEL SPECIFICATION

Fresh tomato shippers provide shipping-point and wholesale markets with 32 distinct tomato qualities during the Florida production season. Shippers sort tomatoes by grade, size, and maturity. The four grades shippers provide are 85 percent U.S. number one,[1] U.S. Combination, U.S. number 2, and U.S. number 3. The five size groups are extra large, large, medium, small, and extra small. The extra-small tomatoes have been restricted from the market since the 1977 season. This restriction is lifted only during periods of short supply and then only temporarily; for example, the restriction was lifted for short periods after freezes in 1977 and 1980 destroyed part of the crop. Because our sample consisted of weekly data in the 1980 and 1981 seasons, we considered only the four larger sizes shipped. The extra-small tomatoes were grouped with the small tomatoes during the short period they were shipped. Finally, there are two maturities, mature green and vine-ripe, resulting in 32 quality types from the combination of four grades, four sizes, and two maturities.

At any particular point in time and space, market prices for different types of tomatoes generally differ. Prices are ranked according to grade and size, with the price of extra-large tomatoes greater than the price of large tomatoes. The price of U.S. number 1 tomatoes is greater than the price of U.S. combination tomatoes. The general pattern of price-ranked order is rarely violated. There is no established price pattern with respect to maturity.

Growers Model

The grower's profit is the difference between gross revenues and total production costs. A marketing restriction has no effect on production costs. A restriction merely prevents the grower from marketing a product already produced.

Before a restriction can be implemented, it must be concluded by the committee governing the Federal Marketing Order (Florida Tomato Committee) that the restriction will benefit the industry. The committee is nominated by the growers and appointed by the U.S.

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[1] When no more than 15 percent of tomatoes in any lot fail to meet the requirements of U.S. number 1 grade and no more than one-third of this 15 percent (or 5 percent) are comprised of defects causing very serious damage, including no more than 1 percent that are soft or affected by decay, such tomatoes may be shipped and designated as at least 85 percent U.S. number 1 grade.

Secretary of Agriculture. The committee normally consists of growers and grower-shippers. For growers, a restriction must be shown to increase revenues from the tomatoes that continue to be sold. This increase in revenues must be more than the loss in revenues from the tomatoes restricted. The profit function for growers can be specified as

$$1) \qquad \pi_G = \sum_{i=1}^{32} (P_i - \overline{PF} - \overline{Z})\, Q_i - CG$$

where

π_G = profits to Florida growers for growing and marketing fresh tomatoes
P_i = the gross f.o.b. shipping-point price received per 30-pound box of tomatoes sold by growers for the i-th quality type (i=1, . . . ,32),
$\overline{PF}$ = the fixed picking fee charged growers per 30-pound box of tomatoes sold,
$\overline{Z}$ = fixed packing and hauling fee charged growers per 30-pound box by the shippers,
Q_i = total 30-pound boxes of tomato type i sold, and
CG = cost of growing tomatoes to harvest.

The picking fee does not increase with restrictions on size because growers supervise picking activities and instruct pickers to harvest only that fruit which is large enough to market. A restriction imposed by grade may, however, cause the picking fee to increase because growers cannot supervise pickers for discriminating grades as well as size.

To facilitate understanding, assume that a restriction is a continuous variable with the effect of reducing quantities of tomatoes marketed such that

$$2) \qquad Q_i = QP_i - R_i \qquad i = 1, \ldots, 32$$

where

QP_i = 30-pound boxes of tomato type i produced (i = 1, . . . ,32), and
R_i = 30-pound boxes of tomato type i produced but restricted from the market (i = 1, . . . ,32).

Substituting equation (2) into (1) and assuming that the price of tomato type i depends on the quantity of each tomato type marketed, then growers would have to satisfy the following first-order conditions to maximize profits with respect to a set of restrictions on tomatoes and have the Hessian be negative definite.

$$3) \qquad \frac{\partial \pi_G}{\partial R_i} = \sum_{j=1}^{32} \left[\left(\frac{\partial P_j}{\partial Q_i}\frac{\partial Q_i}{\partial R_i}\right) Q_i\right] + \left[(P_i - \overline{PF} - \overline{Z})\frac{\partial Q_i}{\partial R_i}\right] = O \quad i = 1, \ldots, 32.$$

The summation of the first bracketed terms in (3) equals the marginal revenue gains (MRG_i) from a restriction. The second bracketed terms equal the marginal revenue losses (MRL_i) from a restriction. The grower would therefore maximize his profits where MRG_i equals MRL_i.

Because of the modus operandi and legal and political considerations, quality restrictions are selective and stepwise. The restrictions are selective in the sense that a specific tomato type is restricted. The tomatoes restricted are generally believed to be the tomatoes of the lowest quality, that is, the smallest size or lowest grade. The restrictions are stepwise in the sense that all or none of a tomato type is eliminated. With these types of restrictions, the hypothesis testing the benefits to growers of a specific set of restrictions on tomato types 1 through r determines whether total revenue gains from the combination of restrictions exceed total revenue losses; i.e.,

$$4) \qquad \int_O^{OP_1} \cdots \int_O^{OP_r} \sum_{i=r+1}^{32} \left[\left(\frac{\partial^r P_i}{\partial Q_1 \ldots \partial Q_r}\right)\left(\frac{\partial Q_1}{\partial R_1}\right) \cdots \left(\frac{\partial Q_r}{\partial R_r}\right)_{Q_i}\right] dR_r \ldots dR_1 > -\sum_{i=1}^{r} \left[\int_O^{QP_i} (P_i - \overline{PF} - \overline{Z})\frac{\partial Q_i}{\partial R_i}\, dR_i\right]$$

where quality types r + 1 through 32 refer to those types not restricted. The left-hand side of expression (4) represents the total revenue gains realized from restricting tomato types 1 through r, while the right-hand side represents the total revenue losses. To test the hypothesis in expression (4) we must, therefore, first estimate a price function for each quality type of tomato, i.e., estimate

$$(5) \qquad P_j = f(\vec{Q}, \vec{X}) \qquad j = 1, \ldots, 32$$

where $\vec{Q}$ is the vector for the quantities of tomato types marketed and $\vec{X}$ is the vector of exogenous factors influencing the price of each tomato type.

Estimating the price functions in expression (5) proved to be impractical. The data used for estimating the functions were the weekly recorded shipments as tabulated by the Florida Tomato Committee. The weekly data showed a high degree of multicollinearity in the quantities of the quality types. Because of this multicollinearity problem, the procedure used was the procedure proposed by Montes. The tomato types were divided into two quality types, those considered for restriction and those not considered. Estimating the price functions in this manner eliminated the multicollinearity problem and also reduced the number of equations to be estimated. Although some explanatory power for specific prices is lost, the cumulative affect of the restriction on average price can be measured. The final general model estimated was

(6) $P_{NR} = f(Q_{nR}, Q_R, \vec{X})$

where P_{NR} is the average value of nonrestricted tomatoes,

$$7) \quad P_{NR} = \sum_{i=r+1}^{32} (P_i Q_i) \Big/ \sum_{i=r+1}^{32} QP_i ,$$

Q_{NR} is the quantity of nonrestricted tomatoes shipped,

$$8) \quad Q_{NR} = \sum_{i=r+1}^{32} QP_i ,$$

and Q_R is the quantity of restricted tomatoes,

$$9) \quad Q_R = \sum_{i=1}^{r} QP_i .$$

Specifying the price function in the form of equation (6) and noting that $\partial Q_i / \partial R_i$ equals -1 simplifies the test of the hypothesis in equation (4) as

$$10) \quad \int_0^{QP_R} \frac{\partial P_{NR}}{\partial Q_R} Q_{NR}\, dQ_R > - \int_0^{Q_R} \overline{(P_R - PF - Z)}\, dQ_R$$

If expression (10) is true, then restricting Q_R tomatoes from the market will be beneficial to the growers.

RESULTS

Data

Data used for analyzing the hypothesis stated in expression (10) were collected from the weekly shipment reports published by the Florida Tomato Committee for the 1979–80 and 1980–81 seasons and from discussions with various representatives of the Florida tomato industry.

Two types of restrictions were considered feasible for the Florida tomato industry: restricting small tomatoes (hereafter called a size restriction) and restricting U.S. number 3 tomatoes (hereafter called a grade restriction). The restrictions were tested by first estimating an f.o.b. price model for each restriction and then deducing the growers' price model by subtracting the costs of picking ($\overline{PF}$) and of packing and shipping ($\overline{Z}$).

F.O.B. Price Model

The general price model proposed for analyzing the effects of restricting tomatoes can be shown as

$$11) \quad P_{NR,t} = \alpha O + \alpha_1 FQ_{NR,t} + \alpha_2 FQ_{NR,t-2} + \alpha_3 FQ_{R,t} + \alpha_4 FQ_{R,t-2} + \alpha_5 (MQ_{NR,t-1} + MQ_{R,t-1}) + \alpha_6 OQ_{t-2} + \alpha_7 P_{NR,t-1} + \Sigma_t$$

where

$P_{NR,t}$ = average f.o.b. price for a 30-pound carton of nonrestricted tomatoes in time period t,
$FQ_{NR,t}$ = total shipments of 30-pound cartons of nonrestricted tomatoes in time period t,
$FQ_{R,t}$ = total shipments of 30-pound cartons of restricted tomatoes in time period t,
$MQ_{NR,t}$ = total crossings of 30-pound cartons of Mexican nonrestricted tomatoes in time period t,
$MQ_{R,t}$ = total crossings of 30-pound cartons of Mexican restricted tomatoes in time period t,
OQ_t = total shipments of tomatoes from all domestic U.S. sources other than Florida in time period t,
Σ_t = random disturbance of the model.

The f.o.b. price was hypothesized to be a function of the shipments from Florida in the current week (time period t) and two weeks prior (time period t − 2). Both quantities were considered because retailers can purchase tomatoes either directly from Florida shippers, in which case current shipments effect retail demand and f.o.b. prices, or from terminal markets, in which case shipments from two weeks prior effect retail demand and f.o.b. prices. A lag of two weeks was considered because of the lag associated with moving Florida shipments to terminal markets (Brooker and Pearson; Bohall). Mexican quantities were lagged one week because most Mexican production is of the vine-ripe maturity and must be shipped through the market channels relatively quickly to ensure quality (Mendoza). The coefficients for restricted and nonrestricted Mexican tomatoes were forced to be the same. Mexico shipped the restricted tomatoes for both restrictions for only short periods of time, restricting their shipment to the U.S. for all other periods. Because of this limited information, the summation of Mexican quantities of restricted and nonrestricted tomatoes was considered one variable in the model estimations.

The shipments from other domestic sources are for total shipments because the marketing order has no control over domestic production outside the designated marketing order area. These shipments were lagged two time periods for two reasons. First, most of these shipments come from California, and the distance requires additional time for these shipments to impact the Florida market. Second, these shipments are mostly mature green tomatoes, which permits them to move slower through the market channel because quality will not deteriorate as fast as quality in vine-ripe tomatoes. Finally, the price of nonrestricted to-

matoes in the previous week was included because Brooker and Pearson concluded that buying and selling brokers base their prices on many factors, including the price received the previous week.

The results of the model estimations are presented in Table 1. The models were estimated using ordinary least squares regression analysis. The Durbin-h statistics indicate that no serial correlation is present in either model. The model for size restrictions yields results consistent with *a priori* expectations; that is, the signs of the coefficients for all quantity variables were negative. The results for the grade restriction model were not consistent with *a priori* expectations. The signs of the coefficients for both variables related to restricted tomatoes were positive, indicating that higher shipments of U.S. number 3 tomatoes would increase the average price for all other tomatoes. Conversations with industry personnel indicated that U.S. number 3 tomatoes are considered an inferior product and that these low-grade tomatoes are poor substitutes for higher-quality tomatoes. The results support these industry comments because of the positive and low significance of the coefficients for restricted tomatoes. In fact, the positive signs suggest that higher prices may cause more low grade tomatoes to be marketed, indicating a need for estimation of a simultaneous equation system where quantities marketed depend on prices received. This was done, yielding a good mapping of the supply function for low grade tomatoes, but the signs or significance of the coefficients for restricted tomatoes in equation (11) were unchanged. It was concluded from the analysis that a grade restriction would benefit growers in the short run.

Table 1. F.O.B. Price Models for Non-restricted Tomatoes.[a]

Regression coefficient	Variable	Equations: Grade restriction	Equations: Size restriction
α_0	Intercept	3.4983	5.5739
		(2.20)	(3.66)
α_1	$FQ_{NR,t}$	-0.2133	-0.0518
		(-2.64)	(-1.19)
α_2	$FQ_{NR,t-2}$	-0.1183	-0.0695
		(-1.27)	(-1.30)
α_3	$FQ_{R,t}$	0.5793	-0.8535
		(1.13)	(-1.31)
α_4	$FQ_{R,t-2}$	0.5883	-1.0679
		(1.16)	(-1.65)
α_5	OQ_{t-2}	-15.5983	-21.4417
		(-1.20)	(-1.73)
α_6	MQ_{t-1}	-0.1308	-0.1081
		(-1.98)	(-1.74)
α_7	$P_{NR,t-1}$	0.8179	0.7191
		(11.60)	(8.78)
R^2		0.81	0.80
F-ratio		32.06	31.74
Durbin-h		0.62	-0.32
Degrees of freedom		61	61

[a] The parameter estimates are listed above the t – values associated with each parameter.

The size restriction was the only quality restriction that was shown to possibly benefit growers. The average direct- and cross-price flexibilities of the variables for the f.o.b. size restriction model are given in Table 2.[2] The direct-price flexibility $\left(\frac{\partial P_{NR,t}}{\partial FQ_{NR,t}} \frac{\overline{FQ}_{NR,t}}{P_{NR,t}}\right)$ is similar to that reported by Firch and Young (Nuckton, p. 161). The direct-price flexibility and cross-price flexibility for lagged nonrestricted Florida shipments ($FQ_{NR,t-2}$) indicate that quantities shipped two weeks prior have slightly more influence than current shipments in determining price. The same relationship holds for the cross-price flexibilities of current and lagged restricted shipments ($FQ_{R,t}$ and $FQ_{R,t-2}$). These results indicate a need for implementing a size restriction as soon as possible, since once a market glut occurs, the effect on prices is greater in two weeks. The results also show the flexibilities for both the nonrestricted and restricted tomatoes to be approximately equal, indicating a rather easy substitution across sizes of tomatoes.

Table 2. Means Flexibilities of the Size Restriction Price Models.

Variable	F.O.B. Model	Grower Model
$FQ_{NR,t}$	-0.0784	-0.1093
$FQ_{NR,t-2}$	-0.1051	-0.1465
$FQ_{R,t}$	-0.0885	-0.1235
$FQ_{R,t-2}$	-0.1108	-0.1545
OQ_{t-2}	-0.0411	-0.0573
$(MQ_{NR,t-1} + MQ_{R,t-1})$	-0.0909	-0.1268

Growers' Price Model

Since the size restriction was concluded to be the only feasible restriction benefiting growers, the picking fee was assumed constant. The growers' price model would then be the f.o.b. price model, less the cost of picking and cost of packing and shipping. The picking fee and packing and shipping fees were assumed to be $2.50 per carton. This fee was within the range charged to growers for these services as reported by Brooke.

Subtracting the picking fee and packing and shipping fees from the f.o.b. price model does not change the parameters of the model; however, it does change the direct- and cross-price flexibilities because of the change in absolute prices. The flexibilities are listed in Table 2 for the mean values of the variables and are larger in absolute value than the flexibilities of the f.o.b. price model. These results show why growers may be more receptive to a restriction than other parties in the Florida tomato industry. That is, the grower price will increase more in relative value than the f.o.b. price.

[2] The flexibilities are reported for the average values for the variables of interest and cannot be used to determine the effects on total revenue of a restriction. Point flexibilities are required to determine the effects on total revenues of a restriction and point flexibilities will change as the values for the variables of interest change.

Size Restriction Simulation

The analysis of the condition in expression (10) was done with a simulation of the grower's model. A restriction was considered to be implemented when the average f.o.b. Florida price for any week was at 50 percent of parity or lower. The restriction was implemented at this price level because it is considerably below the cost of production for growers (Brooke) and because this general price level has rarely been observed prior to the two seasons analyzed. From the 1971–72 season through the 1978–79 season, the average f.o.b. weekly Florida price was below 50 percent of parity only 5.3 percent of all recorded weeks. In the 1979–80 and 1980–81 seasons the average f.o.b. weekly Florida price was below 50 percent of parity 7 (20.6 percent) and 13 (37.1 percent) weeks, respectively, of the 34 weeks within each season.

The restrictions were implemented in the simulation for the week prices were at 50 percent of parity or lower and not lifted until one week after the observed prices were above 50 percent of parity. This implementation procedure assumes that the Florida Tomato Committee can react immediately to current prices. The lifting procedure permits the committee to operate with the restriction until the committee is assured prices have improved enough to allow shipping small tomatoes again without price falling below 50 percent of parity.

The revenue gains to the Florida growers from a restriction were measured in the simulation as equal to the difference between simulated prices with and without the restriction, multiplied by the quantity of nonrestriction until the committee is assured prices have losses equaled the loss in sales revenues from the restricted tomatoes. The results of the simulation indicate that Florida growers could increase their net revenues considerably by imposing a restriction on small tomatoes when prices are at 50 percent of parity or lower. The gains which could have been realized during the 1979–80 and 1980–81 seasons are shown in Table 3. The total net gains represent a potential increase of 11.0 percent for growers' revenues in the 1979–80 season and 33.2 percent in the 1980–81 season. More important, however, is that these gains could have accrued during periods when growers actually incurred net losses and would have increased growers' revenues 75.7 percent during the restriction period in the 1979–80 season and 81.3 percent during the restriction periods in the 1980–81 season.

Table 3. Simulated Gains from Restricting Small Tomatoes.

Item	Season 1979–80	Season 1980–81
Number and Length of Restrictive Periods	1 Period - 8 weeks	1 Period - 8 weeks 1 Period - 7 weeks
$ Increase in Grower Revenues	$15,760,000	$51,284,000
% Increase in Grower Revenues During Restrictions	75.7	81.3
% Increase in Grower Revenues for Season	11.0	33.2

CONCLUSIONS AND IMPLICATIONS

It has been concluded that Florida tomato growers would not benefit from a restriction of U.S. number 3 tomatoes. The analysis indicated that U.S. number 3 tomatoes were poor substitutes for other tomatoes and that a quality restriction of these low-grade tomatoes would not improve growers revenues in the short run.

It was shown, however, that Florida tomato growers could benefit from a restriction on the shipment of small tomatoes during periods of low prices. A restriction of small tomatoes was evaluated when prices were at 50 percent of parity or lower, a price considered well below cost of production. The results showed that growers could have increased revenues during these low price periods by 75.7 percent in the 1979–80 season and 81.3 percent in the 1980–81 season.

Why doesn't the Florida Tomato Committee impose a restrictive regulation on small tomatoes during periods of low prices, as these results suggest they should do to benefit growers? One reason is that the committee is composed of growers and grower-shippers. Because packing and shipping charges are published prior to the season and are constant throughout the season, a restriction will benefit shippers only when the shipper operates on the increasing portion of his average-cost curve and his average cost is greater than the fixed packing and shipping fee he collects. A restriction may, therefore, be beneficial to growers and not to shippers. This conflict of interest is one reason the Florida Tomato Committee has difficulty agreeing on the imposition of a restriction.

Another important problem of the Florida tomato industry is the timing of restrictions. It has been shown that quantities shipped have as much or more influence on prices two weeks after shipment, indicating a need for imposing a restriction as soon as possible. Imposing a restrictive regulation, however, requires at least 30 days and often up to 90 days. If the Florida Tomato Committee waits until prices are at 50 percent of parity or lower before beginning the process of imposing a restriction, the problem can be history before the restriction takes effect. Temporarily removing a restrictive regulation requires only 3 days. The Florida Tomato Committee could impose a restriction on small tomatoes and temporarily remove it until prices are at levels low enough to justify it being reimposed. This procedure would eliminate the timing problem of the restriction. First, however, support for the restriction must be gained from the Florida Tomato Committee, and the restriction must subsequently be approved by the U.S. Secretary of Agriculture.

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