Evaluating Orange Growers' Exercise of Market Power with Marketing Order Volume Control Regulations

Nicholas J. Powers

Abstract. *Previous studies have measured market power when firms consider the consequences of their actions on profits when deciding how much to produce or purchase, or both. In contrast, this study illustrates how to measure the exercise of market power when growers collectively control the quantities sold to a market use via a Federal marketing order but exert no control on the quantities produced. The hypothesis that California-Arizona navel orange growers exercised some market power (but not complete monopolistic power) before 1983 could not be rejected. Growers exercised less market power from 1983 on when a USDA policy change curtailed growers' use of marketing order volume controls.*

Keywords. *Market power, navel oranges, marketing orders, volume controls.*

An important aspect of public policy is detecting and limiting the exercise of significant market power by firms. A firm has market power when it can influence the price received for its output or the price paid for production inputs, or both. Deviations from competitive markets can distort incentives and redistribute benefits to firms who possess market power. Recognizing the importance of the detection problem, economists recently developed and extended techniques for measuring empirically a firm's exercise of market power (Bresnahan, 1989). Many case studies of the exercise of market power focused on apparent oligopolistic or oligopsonistic industries (Appelbaum, 1979, Appelbaum, 1982, Durham and Sexton, 1992, Holloway, 1991, Lopez, 1984, Porter, 1983, Schroeter, 1988, Schroeter and Azzam, 1990, Schroeter and Azzam, 1991, Sullivan, 1985, Sumner, 1981, Wann and Sexton, 1992). Few studies have measured the influence of public regulations on industry's exercise of market power. Those that have include studies of tomato marketing firms in Israel (Melnick and Shalit, 1985), celery growers in Florida (Taylor and Kilmer, 1988), and coconut oil processors in the Philippines (Buschena and Perloff, 1991).

Powers is an agricultural economist with the Commodity Economics Division, ERS.

Some U.S. agricultural marketing programs can facilitate industry's exercise of market power. For example, the Capper-Volstead Act permits farmers to act together for marketing farm products (Heifner and Powers, 1992). The Agricultural Marketing Agreement Act (AMAA) of 1937, as amended, permits growers to determine collectively when, how much, and which produce can be shipped to selected markets, and to jointly raise funds for research and promotion (Heifner and others, 1981, Polopolus and others, 1986, Powers, 1990). The AMAA explicitly intended for growers to raise their prices collectively, and consequently, the act exempted growers from antitrust legislation.

This article illustrates how to measure the exercise of market power by growers who can influence quantities sold to selected markets via a Federal marketing order established under the AMAA. The Federal marketing order for California-Arizona (CA) navel oranges is a case study that authorized handler prorates, enabling the industry to establish a weekly maximum amount for shipment to a market use.

Previous studies have measured market power when firms consider the consequences of their actions on profits when deciding how much to produce. In these cases, the exercise of monopolistic market power is measured by estimating how much output prices exceed the marginal cost of production (Appelbaum, 1979, Appelbaum, 1982). In practice, this measurement involves specifying and estimating a demand for the output, cost function, input demands, and a profit condition. This study explores the measurement of market power in cases where growers collectively control the quantities sold to a market use but exert no control on the quantity produced. Measuring the exercise of market power derived via handler prorates, by contrast, entails estimating the extent to which growers equate marginal revenues in the regulated and nonregulated markets. The measurement of market power in this case involves specifying and estimating commodity demands for the output as well as a grower revenue condition.

Some studies analyzed the consequences of a hypothetical prorate suspension of CA navel oranges (Shepard, 1986, Thor and Jesse, 1981), while other studies explored selected aspects of actual prorate suspensions (Powers and others, 1986, Powers, 1991a and 1991b, Thompson and Lyon, 1989) None of these studies explicitly examined the exercise of market power by growers The general structural model of this article, however, explicitly defines the interrelationships between growers' exercise of market power, quantity supplied to market uses, and demand parameters with market performance Supplies for major market uses and prices are endogenous and determined simultaneously, rather than by predetermined or exogenous events The model includes a parameter measuring the degree of market power exercised by growers On the basis of this estimated parameter, various hypotheses about whether growers are price takers (not influencing prices in markets) or are maximizing revenue can be statistically tested This parameter also permits tests of whether and to what extent major policy changes have affected growers' exercise of market power

Institutions

The CA navel orange industry has operated a marketing order nearly continuously since 1933 The Navel Orange Administrative Committee (NOAC), composed of 11 growers and handlers and a consumer representative, manages the marketing order and votes on a handler prorate each week, which places an upper limit on the quantities handlers can ship for fresh-domestic use (the principal market) The regulations are binding on all handlers shipping navel oranges from the CA area

Actual shipments for fresh-domestic use have nearly equaled the weekly prorate volume when prorates were administered, especially prior to the 1983 season when the NOAC administered nearly season-long prorates [1] This observation suggests that prorates may have influenced annual volumes for this use The amount exported and processed were unrestricted The NOAC cannot set the price of fresh navel oranges but can influence it by adjusting the quantity that the industry sells for fresh-domestic use

Growers can more easily influence price when the marketing order's coverage of the crop's growing area is more extensive Growers covered by the marketing order for CA navel oranges supply about 75 percent of all domestically consumed fresh oranges during the winter season Florida ships most of the remaining supplies of fresh oranges during this season Unlike CA navel oranges, retailers and consumers squeeze some of Florida's fresh marketed oranges for fresh juice Roughly 66 percent of the CA crop entered fresh-domestic use, 24 percent was processed, 8 percent was exported, and 2 percent filled other uses, such as donations and animal feed during the 1980's Annual variation in the share of the CA crop to market uses is mostly between fresh-domestic use and processing

The role of handlers is important because it can affect who obtains the benefits from market power derived from prorates Growers without packinghouses contract with handlers who agree to grove pick, pack, and market navel oranges Sunkist, a grower-owned marketing cooperative, has marketed about 65 percent of the CA crop since 1990, and more of the navel oranges grown in southern California than in central California Southern California exported about 33 percent of its crop compared with about only 6 percent for central California during the mid-1970's to late 1980's Despite these differences, the share of Sunkist's navel oranges shipped for fresh-domestic use and exports has nearly equaled the average for the industry (Mueller and others, 1987) Another marketing cooperative, Central California Orange Growers, has marketed about 20 percent of the crop during the 1990's The remainder of the crop is marketed by proprietary handlers Handlers sell fresh navel oranges to many buyers for regional and national wholesalers and retailers mostly on behalf of growers

Does the dominant marketing cooperative possess monopolistic or monopsonistic power? It has monopolistic influence only when it can limit supplies sold in one or more markets and can exclude rivals from the market (Heifner and Powers, 1992) Sunkist does not satisfy these requirements (Mueller and others, 1987) An open-membership policy bars Sunkist from limiting growers' deliveries to packinghouses, and Sunkist cannot successfully influence f o b prices by unilaterally limiting quantities sold to a market because other handlers and growers would benefit without bearing any of the costs Sunkist's 1-year exclusive marketing contracts with growers and packinghouses appear necessary for efficient short-term marketing rather than excluding rivals Sunkist also lacks monopsonistic influence because of its open-membership policy, and because higher net returns from marketing would be returned to

[1] The marketing season overlaps two calendar years For example, the 1983 season began in fall 1982 and ended in spring 1983

growers as higher prices or patronage refunds [2] For these reasons, rival handlers would also have little monopolistic or monopsonistic power The dominance of an open-membership cooperative suggests that handlers would pass any market power benefits derived from prorates back to growers in the form of higher net returns (grower prices plus patronage refund)

A General Model

NOAC administered season-long prorates over much of the period included in this analysis For this reason, an annual model consisting of the major commodity demands for CA navel oranges along with a revenue condition was developed to help evaluate growers' exercise of market power If adequate weekly data can be identified, the annual model could be extended to assess whether growers' exercise of market power varies within the season

The quantity of fresh navel oranges demanded by domestic buyers is

$$Q_f = f_1 (P_f, Z), \tag{1}$$

where Q_f is quantity for fresh-domestic use, P_f is the grower price of fresh navel oranges, and Z is a vector of exogeneous commodity demand-shifting variables

The quantity of navel oranges demanded by processors is

$$Q_p = f_2 (P_p, X), \tag{2}$$

where Q_p is quantity for processing, P_p is the grower price of navel oranges for processing, and X is a vector of exogenous commodity demand-shifting variables

Navel oranges for processing are squeezed for juice and subsequently blended with other juices and sold as a fruit drink to consumers, and solids are made into jams Consumers eat navel oranges for fresh-domestic use out-of-the-hand mostly at lunch or as a snack Because of dissimilarities in end use, the markets for fresh use and processing are separate, setting up a prerequisite for successful price discrimination Because the estimated coefficients are not different from zero at more than the 0 5 level of significance, the price of processed navel oranges does not appear in the fresh-domestic commodity demand, nor does the price of fresh navel oranges appear in the processing commodity demand (Shepard, 1986) The form of the growers' revenue condition becomes more complicated when commodity demands are interrelated

Because quantities of navel oranges exported are relatively small, they are considered exogenous That is, $Q_e = \bar{Q}_e$, where Q_e is quantity exported and $\bar{Q}_e$ is a constant [3] Because they fetch the same price as navel oranges for fresh-domestic use and are unregulated, exports are important, particularly for southern California growers The influence of exports on the exercise of market power, prices, and shipments for fresh-domestic use and processing is captured in the growers' revenue condition

The small quantities of navel oranges for other uses are also considered exogenous, $Q_o = \bar{Q}_o$, where Q_o is quantity for other uses and $\bar{Q}_o$ is a constant In contrast to exports, quantities to other uses earn nothing

The market clearing identity is

$$\bar{Q} = Q_f + Q_p + \bar{Q}_e + \bar{Q}_o, \tag{3}$$

where $\bar{Q}$ is quantity produced Navel orange trees begin bearing some fruit 6-8 years after planting and continue bearing for 40-75 years Given the physiological characteristics of this perennial tree crop, the assumption that the annual quantity produced is largely predetermined in the short run is reasonable for this analysis, which is based on a relatively short period

Prorates enable growers to limit quantities sold for fresh-domestic use Because exports do not expand much in the short run, some of the quantities of fresh-use quality oranges in excess of the prorated quantities may eventually enter processing In this way, growers can influence how much goes to a given market Growers exercising complete monopolistic power allocate a given quantity produced to maximize revenues, as in

$$\mathscr{L} = \text{MAX } P_f [Q_f + \bar{Q}_e] + P_p [\bar{Q} - Q_f - \bar{Q}_e - \bar{Q}_o] \tag{4a}$$

Exports earn the same price as navel oranges for fresh-domestic use, but quantities for other uses

[2]A reviewer pointed out that to the extent that Sunkist is more efficient than rivals, management may extract benefits from growers by authorizing perks

[3]Export demand estimation was unsuccessful for several reasons First the composition of countries importing navel oranges has changed over time The bulk of exports went to Europe before 1970 Since the mid 1970's, about 75 percent has gone to Japan Singapore, and Hong Kong Second, despite the gradual relaxation of Japanese citrus quotas, import duties remain

are not included since they earn nothing The growers' first-order condition, rearranged, is

$$P_f + (\partial P_f/\partial Q_f)\,[Q_f + \hat{Q}_e] = P_p + (\partial P_p/\partial Q_p)\,Q_p, \quad (4b)$$

where $(\partial P_f/\partial Q_f)$ is the first derivative of the inverse of the commodity demand for fresh-domestic use [equation 1 solved for P_f as a function of Q_f] with respect to Q_f, and $(\partial P_p/\partial Q_p)$ is the first derivative of the inverse of the commodity demand for processing [equation 2 solved for P_p as a function of Q_p] with respect to Q_p Growers maximize revenues by allocating a given quantity of production (less quantities exported and for other uses) between fresh-domestic use and processing until the marginal revenues from sales to fresh uses (fresh-domestic use and exports combined) and processing are equal

Growers may not be able to exercise complete monopolistic power for several reasons First, because marketing opportunities are unevenly distributed across growing regions and marketing organizations (for instance, southern California growers export proportionately more navel oranges than others), NOAC members may be unable to agree on passing the prorate that maximizes industry revenues Second, because the Secretary of Agriculture must approve the prorate before it becomes legally enforceable on all handlers, NOAC members may be reluctant to limit quantities sold for fresh-domestic use by the amount necessary for maximizing revenues Rather than assume growers exercise complete monopolistic power via prorates, I attempt to measure the degree of market power (defined as the degree to which growers maximize revenues) actually exercised by growers This can be done by first restating the first-order condition for growers exercising complete monopolistic power as $P_f - P_p = (\partial P_p/\partial Q_p)\,Q_p - (\partial P_f/\partial Q_f)\,[Q_f + \hat{Q}_e]$, and then including a parameter β, as in

$$P_f - P_p = \beta\,[(\partial P_p/\partial Q_p)\,Q_p - (\partial P_f/\partial Q_f)\,[Q_f + \hat{Q}_e]], \quad (5a)$$

where $\beta\,[(\partial P_p/\partial Q_p)\,Q_p - (\partial P_f/\partial Q_f)\,[Q_f + \hat{Q}_e]]$ is the difference in grower prices in fresh use and processing attributable to growers' exercise of market power β measures the degree of market power actually exercised by growers via prorates, and is implicitly affected by equity and political factors that the NOAC considers when making prorate decisions β also measures the extent to which growers successfully maximize revenues via prorates If $\beta = 1$, growers maximize revenues by equating marginal revenues for fresh use and processing as would a firm exercising complete monopolistic power without supply control In a perfectly competitive market (where growers are price takers), $\beta = 0$, and prices in the two markets are equal A β between 0 and 1 reflects various degrees of market power exercised by growers A β closer to 1 reflects a greater degree to which growers maximize revenues

The preceding approach does not require the explicit modeling of the prorate decision made by the NOAC Rather, the degree of market power exercised by growers via prorates is inferred from actual market outcomes The model incorporates factors the NOAC members discuss before voting on prorate, such as supply, demand, and price conditions

The preceding approach requires that the product is homogeneous If it is not, it can be difficult to differentiate accurately the effects of market power from quality variation in the price difference (equation 5a) Other studies have treated this issue casually or have incorrectly asserted that the (input or output) product is homogeneous However, navel oranges are heterogeneous, and the effects of quality distinction must be sorted out from the exercise of market power in the price difference

Navel oranges are preferred in fresh use because they are seedless and consumers can easily peel the rind The low juice content of processed navel oranges lowers grower prices relative to those for fresh-use navel oranges Navel oranges subsequently processed are profitable, despite negative grower prices, because they represent a part of the production base used in the marketing order from which the growers' prorate is calculated (For a grower, a larger production base increases the maximum quantity of navel oranges eligible for shipment to the higher priced fresh-domestic use) When the NOAC does not administer prorates, growers continue to pick navel oranges destined for processing to reduce insect and disease infestation of the groves When the NOAC does not administer prorates, growers are price takers and profit incentives encourage growers and handlers to ship all navel oranges (which meet minimum fresh-use quality requirements and can be sold at a price covering marginal marketing costs) for fresh use When growers are price takers, the prices in fresh use and processing are related, as in

$$P_f - P_p = \delta + e, \quad (5b)$$

where δ is positive, reflecting the effects of quality distinction, and e is the residual term

In contrast to the competitive market, revenue incentives encourage growers who administer season-long prorates to restrict annual quantities sold to fresh-domestic use Consequently, unpicked navel oranges deteriorate on the trees, so more would likely be processed than otherwise This product diversion would increase the price difference above the level resulting from quality distinction when growers are price takers (equation 5b) The amount of the price difference above the amount for quality distinction represents the price effect from the exercise of market power (equation 5a) Thus, when the NOAC administers prorates, the price difference is composed of two parts the quality distinction effect (as in equation 5b), and the market power effect (as in equation 5a) Combining these terms, the grower price difference is

$$P_f - P_p = \delta + \gamma\{\beta[(\partial P_p/\partial Q_p)\ Q_p - (\partial P_f/\partial Q_f)\ \{Q_f + Q_e\}]\} + e, \qquad (5c)$$

where γ is a binary variable that equals 1 when the NOAC administers prorates, and 0 otherwise

The effect of quality distinction (that is, δ in equation 5c) could be estimated using observations during seasons the NOAC did not administer prorates Unfortunately, the NOAC has not marketed navel oranges an entire season without administering prorates, so it is impossible to estimate the effect of quality distinction directly Several approaches were explored to account for the effect of quality distinction indirectly First, because the price difference is expected to narrow when the crop increases (more abundant supplies of fresh-use navel oranges), δ was specified as a function of total shipments of CA navel oranges Second, δ was also specified as a function of the share of the CA crop for fresh use In both cases, the estimated coefficient was not significantly different from zero at more than the 0 5 significance level A trend variable to measure systematic changes in the price difference over time was no more successful at estimating δ

In lieu of these findings, estimates of δ were provided by observing the range of real grower price differences during the weeks from 1983 to 1989 when the NOAC did not administer prorates On this basis, in estimating equation 5c, δ was assumed to equal several values—\$2 00 (low value), \$2 75 (average value), and \$3 50 (high value) per carton of oranges However, the price differences during the weeks' prorates were not administered and may not be entirely free from the influence of prorates

Annual NOAC Bulletins were reviewed to identify events that likely created unusual crop quality conditions A devastating freeze in 1968 created abnormal crop-quality problems, so a binary variable was included in equation 5c to account for the effect of a freeze on quality distinction

The Empirical Model

The empirical estimation specifies explicit equations for the commodity demands (equations 1 and 2) and revenue condition (equation 5c) The revenue condition uses information from the inverse of the commodity demands, so the inverse of the commodity demands are specified The inverse of the commodity demand for fresh-domestic use is

$$P_f = a_0 + a_1\ Q_f + a_2\ Z + e_f, \qquad (1')$$

where a_0 is an intercept, a_1 and a_2 are estimated coefficients, and e_f is the error term The equation is linear in coefficients and variables The linear functional form was selected because the price flexibility was statistically less than 1 for the semi-logarithmic and double-logarithmic forms during some seasons This finding suggests the unlikelihood that growers had restricted volumes for fresh-domestic use beyond the revenue-maximizing point [4] The vector Z contains income and the price of fresh Florida oranges (Powers, 1991a, Shepard, 1986) Prices or quantities of grapefruit, bananas, and apples and prices of marketing inputs (transportation and labor costs) were omitted from the vector Z because each of the estimated coefficients was not different from zero at more than the 0 6 significance level This omission did not affect the estimated coefficient for Q_f, so critical findings about β in equation 5c are unaffected The price rather than the respective quantities of Florida oranges was included because the explanatory power of the equation was larger

The inverse of the commodity demand for processing is linear in coefficients and variables as

$$P_p = b_0 + b_1\ Q_p + b_2\ X + e_p, \qquad (2')$$

where b_0 is an intercept, b_1 and b_2 are estimated coefficients, and e_p is the error term The vector X includes income and the price of Florida oranges for processing (Powers, 1991a, Sheppard, 1986) Prices or quantities of grapefruit juice and apple juice were omitted from the vector X because each of the estimated coefficients was not different from zero at more than the 0 6 significance level

[4] The estimated degree of market power exercised by growers was not sensitive to the three functional forms for the inverse commodity demand as indicated by stable estimated values of β in equation 5c

The relationship between the endogenous quantity variables (Q_f and Q_p) and the exogenous quantity variables is given by the market-clearing identity, restated as

$$Q_p = \bar{Q} - \bar{Q}_e - \bar{Q}_o - Q_f \qquad (3')$$

Using information from equations 1' and 2', the growers revenue condition is

$$P_f - P_p = \delta + c_o \text{ FREEZE} + \beta[b_1 Q_p - a_1 [Q_f + \bar{Q}_e]] + e_\beta, \qquad (4')$$

where c_o is an estimated coefficient and e_β is the residual The binary variable FREEZE accounts for the effect of a freeze on crop quality and thus on the price difference Using estimates of a_1 and b_1 from equations 1' and 2', β is identified in equation 4'

Growers administered season-long prorates for many years, until 1983, when USDA encouraged growers to limit the number of weeks with prorate in place Thereafter, the NOAC administered prorates until 60-75 percent of the crop had been marketed To account for the potential impact of this policy change, β was specified as

$$\beta = \beta_0 + \beta_1 D_{1983}, \qquad (5')$$

where β_0 is an intercept, β_1 is an estimated coefficient, and D_{1983} is a binary variable that equals 1 from 1983 on [5] Because growers had less ability to influence seasonal quantities for market uses from 1983 on, the expected sign of β_1 is negative

To account for inflation and population changes over time, the prices in equations 1' and 2' were inflation-adjusted and the quantities in equations 1'-3' were in per capita Equation 4' thus, is in terms of per capita and real prices [6]

Data

USDA establishes annual prices for fresh and processed CA navel oranges, and fresh and processed Florida oranges Each price is an average of within-season grower prices weighted by the corresponding within-season shipments The prices of fresh and processed Florida oranges include Florida's early, midseason, and Valencia oranges

Quantities of CA navel oranges for fresh-domestic use, processing, exports, and other uses are from annual NOAC reports, on a per capita basis The Economic Research Service, USDA, furnished U S population data as of January 1 Disposable income data are from the U S Department of Commerce All prices and income were inflation-adjusted by dividing the respective variables by the consumer price index (CPI) (1982-84 = 1 00) for all items CPI's are from the U S Department of Labor The observations cover 1965-89 Table 1 shows the mean and standard deviations for the variables

Findings

Do growers exercise market power? Did the degree of market power exercised by growers change when prorate use was curtailed in 1983? To answer these questions, equations 1' and 2' were estimated first by using two-stage least squares (2SLS), and then were inserted the unbiased estimates of a_1 and b_1 into equation 4' Equation 4' subsequently was estimated by 2SLS

Table 2 shows the estimated coefficients, corresponding standard errors, and level of significance for the two price-dependent commodity demands Each of the estimated coefficients for the inverse commodity demand for fresh-domestic use have the expected signs, and most are different from zero at

---

[5]The Cost of Living Council pressured the NOAC to increase prorate quantities during the latter part of the 1974 season A binary variable for the 1974 season was included in preliminary specifications of equation 5c to account for the potential impact of this policy change But, it was excluded because the estimated coefficient was not different from zero at even the 0 5 significance level

[6]Growers are interested in maximizing industry revenue, not real per capital revenue The two are equivalent The objective for growers maximizing total revenue is

$$\mathcal{L} = \text{MAX } P_f [Q_f + \bar{Q}_e] + P_p [\bar{Q} - Q_f - \bar{Q}_o]$$

where the P's are nominal prices and the Q's are shipments And, the first-order condition for growers maximizing total revenue is

$$P_f + (\partial P_f/\partial Q_f) [Q_f + \bar{Q}_e] - P_p [\partial P_p/\partial Q_p) Q_p = 0$$

The objective for growers maximizing total revenue can be restated as

$$\mathcal{L} = \text{MAX POP CPIA } [P_f [Q_f + \bar{Q}_e] + P_p [\bar{Q} - Q_f - \bar{Q}_e - \bar{Q}_o]]$$

where the P's now are inflation-adjusted prices, the Q's now are per capita quantities, POP is population, and CPIA is the inflation-adjusting index The first-order condition for growers maximizing total revenue in this case is

$$\text{POP CPIA } [P_f + (\partial P_f/\partial Q_f) [Q_f + \bar{Q}_e] - P_p + (\partial P_p/\partial Q_p] = 0$$

which, by division, is equivalently

$$P_f + (\partial P_p/\partial Q_f) [Q_f + \bar{Q}_e] - P_p + (\partial P_p/\partial Q_p) Q_p = 0$$

Thus, maximizing total revenue implies maximizing real per capita revenue

Table 1—Means and standard deviations, 1965-89 annual data

Variables	Mean	Standard deviation
Endogenous		
Real grower price for fresh CA navel oranges ($/37 5-lb carton)	4 17	1 37
Real grower price for processed CA naval oranges ($/carton)	–0 38	0 47
Quantity of CA navel oranges for fresh-domestic use (cartons per million U S persons)	158,665	33,976
Quantity of CA navel oranges for processing (cartons per million U S persons)	56,762	25,099
Exogenous		
Real grower price for fresh Florida oranges ($/90-lb box)	6 03	1 87
Real grower price for processed Florida oranges ($/box)	4 88	1 40
Total quantity of CA navel oranges (cartons per million U S persons)	237,526	60,786
Quantity of CA navel oranges for exports (cartons per million U S persons)	15,857	8,240
Quantity of CA navel oranges for other uses (cartons per million U S persons)	6,241	1,940
Real U S disposable income (dollars per capita)	9,866	1,133

Table 2—Two-stage least squares estimates, 1965-89 annual data

Item	Coefficient	Asymptotic standard error
Inverse commodity demand for CA navel oranges for fresh-domestic use		
Intercept	8 235	0 892*
Quantity of CA navel oranges for fresh-domestic use	–0 000036	0 000005*
Real grower price for fresh Florida oranges	0 207	0 058*
Real U S disposable income	0 0001	(0 00004)
Correlation between predicted and actual values = 0 942		
Durbin-Watson = 1 370		
Inverse commodity demand for CA navel oranges for processing		
Intercept	0 714	0 525
Quantity of CA navel oranges for processing	–0 000004	0 000002*
Real grower price for processing Florida oranges	0 213	0 043*
Real U S disposable income	–0 00019	0 00005*
Correlation between predicted and actual values = 0 831		
Durbin-Watson = 1 876		

*Signifies that the estimated coefficient is different from zero at the 0 1 significance level

conventional levels of significance The correlation of the predicted and actual prices of fresh navel oranges is 0 942 The Durbin-Watson statistic is 1 370 and does not indicate a first-order autocorrelation scheme in the errors Each of the estimated coefficients for the inverse commodity demand for processing display the expected signs and all are different from zero at conventional levels of significance Income's negative influence may reflect a consumer switch from fruit drinks (made with processed navel oranges) to juices, such as orange or grapefruit, as disposable income increases The correlation of the predicted and actual prices for processed navel oranges is 0 831 The Durbin-Watson statistic is 1 876, suggesting the absence of first-order autocorrelation in the residuals

Table 3 summarizes results from the price difference equations Each of the estimated coefficients exhibits the expected sign, and all are different from zero at conventional levels of significance The estimates of the β's vary slightly for the assumed values of δ but are consistent in two ways First, the estimates of β before 1983 (β_0) are positive and less than 1 Second, the estimates of the change in β from 1983 on (β_1) are negative The estimated coefficient for β before 1983 (that is, prior to the curtailment of prorate use) is 0 441 with a 95-percent confidence interval of 0 350 to 0 532 when δ = 2 00, 0 312 with a 95-percent confidence interval of 0 228 to 0 395 when δ = 2 75, and 0 182 with a 95-percent confidence interval of 0 105 to 0 259 when δ = 3 50 Because these confidence intervals are between 0 and 1, price-taking behavior and the exercise of complete monopolistic power are both rejected On this basis, the hypothesis of growers exercising some monopolistic power before 1983 is not rejected

The policy change in 1983 provided an opportunity to test whether growers exercised less market power from 1983 on when prorate use was curtailed Growers' exercise of market power fell from 1983 on (β_1 = –0 206 when δ = 2 00, β_1 = –0 176 when δ = 2 75, and β_1 = –0 145 when δ = 3 50) The estimate of growers' exercise of market power from 1983 on ($\beta_0 + \beta_1$) is 0 235 when δ = 2 00, 0 136 when δ = 2 75 and 0 036 when δ = 3 50 The hypothesis that growers exercised complete monopolistic power from 1983 on is rejected at more than the 0 05 level of significance, based

Table 3—Two-stage least squares estimates, 1965-89 annual data[1]

Item	δ = 2 00	δ = 2 75	δ = 3 50
	Coefficient (Asymptotic standard error)	Coefficient (Asymptotic standard error)	Coefficient (Asymptotic standard error)
Growers' exercise of market power (price difference)			
Freeze	5 792	5 299	4 806
	(1 096)*	(1 012)*	(0 931)*
β_0	0 441	0 312	0 182
	(0 046)*	(0 043)*	(0 039)*
β_1	–0 206	–0 176	–0 145
	(0 071)*	(0 066)*	(0 060)*
Correlation between predicted and actual values	0 575	0 636	0 694

[1]The Durbin-Watson is not reported because it is not valid in equations without an estimated intercept A comparable test in this case, is to regress the residuals for this equation against the 1-year lag of residuals and test the estimated coefficient for significance from zero The absolute value of the t-ratio for the coefficient for the lag of residuals was less than 0 3, suggesting the absence of first-order autocorrelation

*Signifies that the estimated coefficient is different from zero at the 0 1 level of significance

on calculated t-ratios for complete monopolistic power from 1983 on ($\beta_o + \beta_1 = 1$) of –8 966 when δ = 2 00, –10 971 when δ = 2 75, and –13 291 when δ = 3 50 And based on calculated t-ratios for price taking from 1983 on ($\beta_o + \beta_1 = 0$) of 2 751 when δ = 2 00, 1 721 when δ = 2 75, and 0 487 when δ = 3 50, the hypothesis that growers were price takers from 1983 on is rejected at the 0 05 significance level if δ = 2 00 or 2 75 but not if δ = 3 50

Estimating equations 1', 2', and 4' by three-stage least squares (3SLS) can improve the efficiency of the estimated parameters Because of convergence problems, the estimated coefficients for a_1 and b_1 were constrained to equal the unbiased estimates from 2SLS when estimating the equations by 3SLS Table 4 contains estimated results for 3SLS when δ = 2 75 The results for the 3SLS and findings about market behavior were consistent with the results from 2SLS

Some Impacts of the Marketing Order

Using the estimates of the model's demand parameters and values for the exogenous variables, prices, quantities, and revenues can be solved for the unrestricted use of prorate, restricted use of prorate, and competitive cases Solving for market performance in the three cases involved using values of the exogenous variables during 1989 and the parameters estimated by 3SLS when δ = 2 75

When growers' use of prorate is unrestricted ($\beta = \beta_o$), an estimated 56 7 percent of the crop fills fresh-domestic use, 30 9 percent is processed, 9 7 percent is exported, and 2 7 percent fills other uses The estimated real prices of fresh and processed navel oranges are $4 21 and –$0 60 per carton Estimated real industry revenue is $184 million When growers' prorate use is restricted ($\beta = \beta_o + \beta_1$), an estimated 66 3 percent of the crop fills fresh-domestic use and 21 3 percent is processed Shares to exports and other uses are similar to shares under unrestricted use The estimated real prices of fresh and processed navel oranges are $3 22 and –$0 49 per carton and estimated real industry revenue is $165 million ($18 7 million less than if growers prorate use is unrestricted) In the competitive case ($\beta = 0$), an estimated 74 6 percent of the crop fills fresh-domestic use and 13 percent is processed The estimated real prices of fresh and processed navel oranges are $2 36 and –$0 39 per carton and estimated real industry revenue is $137 1 million ($46 9 million less than if growers' prorate use is unrestricted)

Figure 1 illustrates marketing order effects on prices and shipments for fresh-domestic use and processing In the competitive case, $\hat{Q}_f$ goes for the fresh-domestic use and ($\hat{Q} - \hat{Q}_f$) is processed The price difference is δ In contrast, growers who maximize industry revenue move along the marginal revenue schedules for the commodity demands and equate marginal revenues by shipping only Q_f^* for fresh-domestic use but ($\hat{Q} - Q_f^*$) for processing The price of fresh navel oranges is higher when growers exercise monopolistic power, but the price of processing navel oranges is lower

Conclusions

This article's structural model illustrates how to measure the exercise of market power by growers who can influence the quantities shipped for a market use The hypothesis that growers exercised some market power via marketing order prorates (but not complete monopolistic power) prior to 1983 could not be rejected Growers appear to have exercised less market power from 1983 on, which coincides with a policy curtailing growers' use of prorate

Table 4—Simultaneous equation estimates for δ = 2.75, 1965-89 annual data

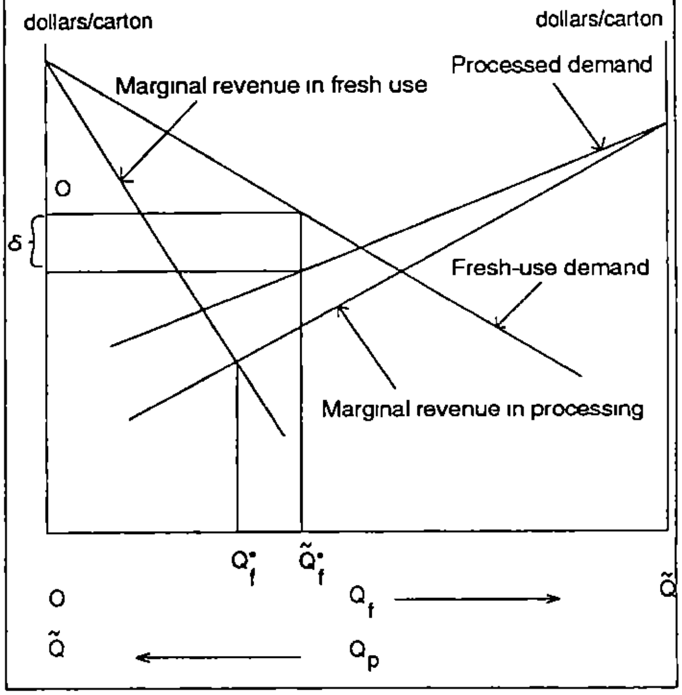
Item	Coefficient	Asymptotic standard error
Inverse commodity demand for CA navel oranges for fresh-domestic use		
Intercept	8 277	0 779*
Quantity of CA navel oranges for fresh-domestic use	-0 000036	
Real grower price for fresh Florida oranges	0 184	0 045*
Real U S disposable income	0 00005	0 00007
Correlation between predicted and actual values = 0 942, Durbin-Watson = 1 366		
Inverse commodity demand for CA navel oranges for processing		
Intercept	0 606	0 459
Quantity of CA navel oranges for processing	-0 000004	
Real grower price for processing Florida oranges	0 253	0 034*
Real U S disposable income	-0 0002	0 00004*
Correlation between predicted and actual values = 0 829, Durbin-Watson = 1 992		
Growers' exercise of market power (price difference)		
Freeze	4 241	0 762*
β_0	0 319	0 038*
β_1	-0 192	0 053*
Correlation between predicted and actual values = 0 597, Durbin-Watson[1]		

[1]The Durbin-Watson is not reported because it is not valid in equations without an estimated intercept A comparable test, in this case, it to regress the residuals for this equation against the 1-year lag of residuals and test the estimated coefficient for significance from zero The absolute value of the t-ratio for the coefficient for the lag of residuals was less than 0 3, suggesting the absence of first-order autocorrelation

*Signifies that the estimated coefficient is different from zero at the 0 1 significance level

Figure 1

Prices and quantities



References

Appelbaum, Elie 1979 "Testing Price Taking Behavior," *Journal of Econometrics* Vol 9, pp 283-94

Appelbaum, Elie 1982 "The Estimation of the Degree of Oligopoly Power," *Journal of Econometrics* Vol 12, pp 287-99

Bresnahan, Timothy F 1989 "Empirical Studies of Industries with Market Power," *Handbook of Industrial Organization* Richard Schmalensee and Robert D Willig (eds) Amsterdam Amsterdam-Holland, pp 1,011-57

Buschena, David E , and Jeffrey M Perloff 1991 "The Creation of Dominant Firm Market Power in the Coconut Oil Export Market," *American Journal of Agricultural Economics* Vol 73, pp 1,000-8

Durham, Catherine A , and Richard J Sexton 1992 "Oligopsony Potential in Agriculture Residual Supply Estimation in California's Processing Tomato Market," *American Journal of Agricultural Economics* Vol 74, pp 962-72

Holloway, Garth J 1991 "The Farm-Retail Price Spread in an Imperfectly Competitive Food Industry," *American Journal of Agricultural Economics* Vol 73, pp 979-89

Heifner, Richard, Walter Armbruster, Edward Jesse, Glenn Nelson, and Carl Shafer 1981 *A Review of Marketing Orders for Fruits, Vegetables, and Specialty Crops* AER-477 U S Dept Agri , Agri Mkt Serv

Heifner, Richard G , and Nicholas J Powers 1992 *Agricultural Cooperatives and Undue Price Enhancement* Unpublished manuscript U S Dept Agri , Econ Res Serv

Lopez, Raymond E 1984 "Measuring Oligopoly Power and Production Responses of the Canadian

Food Processing Industry," *Journal of Agricultural Economics* Vol 35, pp 219-30

Melnick, Rafi, and Haim Shalit 1985 "Estimating the Market for Tomatoes," *American Journal of Agricultural Economics* Vol 67, pp 573-82

Mueller, Willard F , Peter G Helmberger, and Thomas W Paterson 1987 *The Sunkist Case A Study in Legal-Economic Analysis* Lexington, MA D C Heath and Company, Lexington Books

Polopolus, Leo C , Hoy F Carman, Edward V Jesse, and James D Shaffer 1986 *Criteria for Evaluating Federal Marketing Orders Fruits, Vegetables, and Specialty Commodities* U S Dept Agri , Econ Res Serv

Powers, Nicholas J 1991a "Effects of Marketing Order Prorate Suspensions on California-Arizona Navel Oranges," *Agribusiness An International Journal* Vol 7, pp 203-29

__________ 1991b "Marketing Order Impacts on Farm-Retail Price Spreads," *American Journal of Agricultural Economics* Vol 73, pp 507-10

__________ 1990 *Federal Marketing Orders for Fruits, Vegetables, Nuts, and Specialty Crops* AER-629 U S Dept Agri , Econ Res Serv

Powers, Nicholas J , Glenn A Zepp, and Frederic L Hoff 1986 *Assessment of a Marketing Order Prorate Suspension A Study of California-Arizona Navel Oranges* AER-557 U S Dept Agri , Econ Res Serv

Porter, Robert H 1983 "A Study of Cartel Stability The Joint Executive Committee, 1880-1886," *The Bell Journal of Economics* Vol 14, pp 301-14

Schroeter, John R 1988 "Estimating the Degree of Market Power in the Beef Packing Industry," *Review of Economics and Statistics* Vol 70, pp 156-62

Schroeter, John R , and Azzeddine Azzam 1990 "Measuring Market Power in Multi-Product Oligopolies The U S Meat Industry," *Applied Economics* Vol 22, pp 1,365-76

__________ 1991 "Marketing Margins, Market Power, and Price Uncertainty," *American Journal of Agricultural Economics* Vol 73, pp 990-99

Shepard, Lawrence 1986 "Cartelization of the California-Arizona Orange Industry, 1934-1981," *Journal of Law and Economics* Vol 29, pp 86-123

Sullivan, Daniel 1985 "Testing Hypotheses About Firm Behavior in the Cigarette Industry," *Journal of Political Economy* Vol 93, pp 586-98

Sumner, Daniel A 1981 "Measurement of Monopoly Behavior An Application to the Cigarette Industry," *Journal of Political Economy* Vol 89, pp 1,010-19

Taylor, Timothy G , and Richard L Kilmer 1988 "An Analysis of Market Structure and Pricing in the Florida Celery Industry," *Southern Journal of Agricultural Economics* Vol 20, pp 35-43

Thompson, Gary D , and Charles C Lyon 1989 "Marketing Order Impacts on Farm-Retail Price Spreads The Suspension of Prorates on California-Arizona Navel Oranges," *American Journal of Agricultural Economics* Vol 71, pp 647-60

Thor, Peter K , and Edward V Jesse 1981 *Economic Effects of Terminating Federal Marketing Orders for California-Arizona Oranges* TB-1664 U S Dept Agri , Econ Res Serv

Wann, Joyce J , and Richard J Sexton 1992 "Imperfect Competition in Multiproduct Food Industries with Application to Pear Processing," *American Journal of Agricultural Economics* Vol 74, pp 980-90