Journal of Agricultural and Applied Economics, 28,2(December 1996):263–277

Marketing Order Suspensions and Fresh Lemon Retail-FOB Margins

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ABSTRACT

In August 1994, the Secretary of Agriculture announced the termination of the marketing order and the associated flow-to-market, or prorate, controls for fresh California and Arizona (CA/AZ) lemons. Lemon growers and handlers have expressed concern over the impact of this decision on retail-FOB margins. This study presents an econometric model of fresh lemon marketing margins that tests for the presence of buyer and seller market power during previous periods of marketing order suspension. The results show that buyer and, to a lesser extent, seller market power cause retail-FOB margins to widen during periods of prorate suspension.

Key Words: conjectural variations, lemons, marketing order, monopsony power, retail-FOB margins.

The Secretary of Agriculture formally suspended the federal marketing order for California and Arizona (CA/AZ) lemons in August of 1994, ending the system of controlled allocations between the fresh and processing lemon markets known as "prorates." Prorates were the primary mechanism through which the marketing order was able to control market supply, and thereby cause lemon prices to rise. Technically, prorates refer to the weekly amount each handler could ship to the fresh market as a proportion of total industry shipments. These amounts were set by the Secretary of Agriculture upon recommendation of the Lemon Administrative Committee (LAC)—a board of handlers, growers, and consumer representatives—based on consideration of the strength of demand, state of supply, and projections of future needs. In general, the objective of the marketing order was to establish an "orderly market" for lemons. Nominally, the definition of an orderly market is one that has "an even flow to market at stable prices," but the actual purpose of the marketing order was to raise lemon prices to the parity level (Carman and Pick 1990).

Consumer groups lobbied for the termination of the lemon prorate system, arguing that it was merely a federally sanctioned agricultural cartel. Many growers, however, maintained that price stability under the marketing order was necessary to prevent cycles of boom and bust which cause inefficient investment and removals. The larger cooperative handlers, not surprisingly, supported the grower position, although several independent and coop-

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The authors thank Gary Thompson, Sam Gao, Paul Patterson, and two anonymous reviewers for their helpful comments.

erative-affiliated handlers were accused of cheating on the prorate system. Clearly, failure of the marketing order was due to forces both internal (independent handlers) and external (consumers) to the industry.

Consumer and producer interests also coincide on the issue of retail-FOB margins. Such margins are often used as a measure of market performance, or the ability of the marketing system to pass along production cost savings to consumers. Neither consumers nor producers wish to see suspension of the prorate system result in a greater share of the lemon dollar going to retailer profit.

Previous studies of the effect of prorates implicitly treat the prorate suspension decision as exogenous to lemon supply conditions. Typically, decisions to temporarily suspend the prorate were made only when board members felt controlling deliveries would not help stabilize market prices or quantities.[1] Failure to account for the endogeneity of the suspension decision with lemon supply will produce misleading conclusions about the effect of regulation on marketing margins. This study attempts to explain the decision to suspend and suspension effects as simultaneous economic outcomes.

Failure to allow for potential exercise of buyer or seller market power also introduces a source of bias to estimates of the effect of regulation on margins. Margins under conditions of oligopsony or oligopoly respond not only to changes in quantities allowed onto the market, but also to regulatory factors that can influence a firm's ability to use its market power. Rather than presume such power exists, however, this study tests for market imperfections during periods when the prorate was in effect, and periods when it was not.

Consequently, the objective of this study is to determine the effect of lemon prorate suspension on the retail-FOB marketing margin. While several studies have attempted to determine the welfare implications of various marketing order provisions (see, for example, Powers 1991a), our investigation does not attempt to assign cost or benefit values to any of the stakeholders in the lemon industry. We do, however, consider both the endogeneity of prorate suspension decisions with supply and the possibility of imperfect competition among lemon buyers and sellers. In the first section, an economic model of fresh lemon retail-FOB margins under imperfect competition is presented. This model demonstrates the likely effects of prorate suspension on the exercise of buyer and seller power, and consequently, on margins. In the next section, we develop an empirical model of lemon margins that allows for the possibility of market power and suspension endogeneity. The third section consists of an explanation of how the empirical model is estimated, including a discussion of the data, estimation methods, and empirical results. Finally, several implications are drawn regarding the future of lemon marketing, and other marketing-order-controlled commodities in California and Arizona.

Economic Model of Citrus Margins

Several studies have used data from navel orange suspension periods in the 1980s to predict the likely impacts of marketing order termination on prices, shipments, allocations, and margins. In separate investigations by Thor and Jesse, and by Powers, Zepp, and Hoff, the authors argue that prorate suspension causes the price of fresh citrus to fall. Without the ability to use the marketing order flow-to-market controls to price discriminate between the price-inelastic fresh market and the price-elastic processing market, lemon sellers allocate more to the fresh market. Carman and Pick's (1988) analysis of the 1985–86 lemon prorate suspension shows that the fresh market price not only falls without the prorate, but also becomes more variable. Although they do not explicitly address the problem of retail-FOB marketing margins, Carman and Pick suggest that an increase in buyer market power without the prorate could lead to a reduction in grower prices without a corresponding fall in

[1] For example, during the 1985–86 season, storage problems caused the fresh lemon availability to be far lower than normal. Whereas flow-to-market control can stabilize prices and deliveries during times of overproduction, prorates would have been irrelevant during the 1985–86 shortage.

the retail price. Such buyer power is a distinct possibility in the lemon industry, due to the geographic dispersion of growers and cyclical overproduction problems (Kinney et al.).

Our study extends the existing research in three ways. First, the analysis focuses on marketing margins to determine the effect of terminating flow-to-market control on the growers' share of the retail lemon dollar. Second, the study models the decision to suspend the prorate as endogenous. Because many of the factors that determine lemon supply also influence the decision to suspend prorates, the decision to suspend cannot be considered as an exogenous event. Third, the model does not presume that perfect competition prevails in the fresh lemon market, but tests for the possibility that both lemon buyers and sellers exercise a degree of market power. Tests of market power employ an econometric framework that has proven valuable in the study of marketing margins in other industries, particularly in beef and pork packing.

Empirical analyses of imperfect agricultural markets often employ the "new empirical industrial organization" (NEIO) paradigm. Azzam and Pagoulatos; Schroeter; and Schroeter and Azzam (1990, 1991) adopt this approach in their study of oligopsony and oligopoly power in meat packing industries. Wann and Sexton apply the NEIO to the tree-fruit industry and find evidence of both buying and selling market power by pear processors. Contrary to earlier work in the processing tomato industry, Durham and Sexton find limited support for claims of oligopsony behavior. In their analysis of the effects of regulation on market power, Melnick and Shalit find that marketing board provisions which set purchase quantities and minimum prices are insufficient to keep Israeli tomato market agents from exercising oligopsony power—to the detriment of farmers. Taylor and Kilmer employ an NEIO approach to show that growers do not use the Florida celery marketing order to raise prices above the perfectly competitive level.

Others favor more traditional approaches to margin analysis. Brester and Musick review several studies that use reduced-form price spread models. These models consist of the markup model, the price of marketing services model, and the relative price spread model. Of these, only the relative price spread model is consistent with the predictions of a more complete model of margin determination. Using the relative price spread model to analyze the CA/AZ navel orange market, Thompson and Lyon present evidence demonstrating that periods of prorate suspension cause the retail-FOB margin to narrow. Powers (1991b), on the other hand, uses a structural model of the navel market to find the opposite, i.e., margins are likely to be greater during times of suspension because greater quantities move into the less elastic fresh market. Neither of these studies considers the effect of prorate suspension on the relationship between growers or handlers and the ultimate retail buyer of lemons.

If it is true that the marketing order effectively sanctions a grower cartel, as shown by Powers (1993), then terminating the prorate system should cause both farm and retail prices for fresh lemons to move toward the perfectly competitive level. However, the marketing order was originally established with a purpose of allowing growers to countervail monopsony power by lemon buyers. Consequently, the alternative to monopoly selling power is not, in fact, perfect competition, but a degree of monopsony power on the part of lemon buyers. Therefore, rather than an expectation that margins will narrow, this suggests that the retail-farm margin may in fact widen. Determining the relative effects of buyer and seller power requires explicit consideration of lemon buyer power and the role of cooperative pricing.

There are many reasons to expect imperfect competition among fresh lemon buyers. First, fresh lemons share many of the characteristics described by Rogers and Sexton as being conducive to buyer power because they are "bulky, and/or perishable, causing shipping costs to be high, restricting the products' geographic mobility, and limiting farmers' access to only those buyers located close to the production site" (p. 1143). Second, Rogers and Sexton argue that buyer concentration is likely to be higher than seller concentration due to the specialized needs of buyers. While few nonagricultural inputs substitute for farm products in food processing, it is also true that farm products cannot readily substitute for other processing inputs. Third, and most important for lemon growers, Rogers and Sexton maintain that grower investments in specialized, sunk assets cause a barrier to exit and, hence, inelastic product supply. Further, in 1987, the average four-firm concentration ratio (CR-4) for grocery stores among all standard metropolitan statistical areas (SMSAs) in the U.S. was 58.3% [U.S. Department of Agriculture/Economic Research Service (USDA/ERS) 1994]. A CR-4 of greater than 50% is taken to be an indicator of the potential for imperfect competition, on both the buying and the selling side of the retail market. Beyond these structural facts, power exists in the output market simply because lemons constitute a small proportion of consumer budgets, there are few good substitutes, and they are often purchased as a complement to another inelastically demanded good (alcoholic beverages, water, or for baking). Taken together, these conditions suggest a strong a priori case for imperfect competition in the lemon market.

Recognizing this potential for lemon buyer power, growers established a voluntary marketing agreement to control fresh market sales as early as 1925. The California Fruit Growers' Exchange, today's Sunkist Growers cooperative, was the primary outgrowth of this agreement. Beginning with a grower market share of over 90%, marketing conditions began to deteriorate until "increasing production, lower prices, and lack of full participation in the marketing agreement led to enactment of a federal marketing order in 1941" (Kinney et al., p. 3). Under the marketing order, Sunkist managed to maintain a market share of greater than 50%, so lemon buyers exercise market power subject to the constraint of dealing with a cooperative seller.[2] Sunkist's ability to sustain a high market share without the marketing order is, however, of some question.

Royer and Bhuyan develop a model of output and price determination under various relationships between farmer cooperatives and farm-product buyers. Adopting the perspective of the fresh lemon retailer (or wholesaler), the current model assumes the most general case where the retailer can exercise no market power (perfect competitor) or can use full monopoly or monopsony market power. Assume retailers receive a price $P_r(q)$ from consumers in market i and pay the cooperative handler j a price $P_g(q)$ for q_{ij} boxes of lemons, and assume that the cost of transporting and retailing lemons is a constant k per unit. Therefore, the retailers' profit maximization problem is

$$(1) \qquad \max_{q_{ij}} [\pi_r] = \max_{q_{ij}} [P_r q_{ij} - P_g q_{ij} - k q_{ij}].$$

Growers, through their handlers, supply up to the point where the price is equal to the marginal costs of production, so their inverse supply function is written: $P_g = MC_g$. Substituting this expression into (1), the first-order condition for the retailer becomes

$$(2) \qquad \frac{\partial \pi_r}{\partial q_{ij}} = \left(P_r + q_{ij}\frac{\partial P_r}{\partial q}\frac{\partial q}{\partial q_{ij}}\right) - \left(MC_g + q_{ij}\frac{\partial MC_g}{\partial q}\frac{\partial q}{\partial q_{ij}}\right) - k = 0.$$

Multiplying the first term by (q/q) and (P_r/P_r), and the second by (q/q) and (MC_g/MC_g), and summing over all handlers and markets provides the market markup function in general elasticity form:

$$(3) \qquad \frac{\partial \pi_r}{\partial q} = P_r\left(1 + \frac{\theta}{\eta}\right) - MC_g\left(1 + \frac{\phi}{\epsilon}\right) - k = 0,$$

[2] Lemon cooperatives are "active" in the sense of Royer and Bhuyan to the extent that they dominate the Lemon Administrative Committee, which recommends the weekly flow-to-market, but are "passive" in the sense that they cannot control the amount of output of their member-growers. As shown by Royer and Bhuyan, however, this distinction is immaterial to the equilibrium price and quantity when the buyer is dominant.

where η is the own-price elasticity of demand for lemons, and ϵ is the elasticity of supply of lemons. In equation (3), the ratio of θ, the conjectural elasticity of demand, to η shows the degree of market power exercised by the retailer in the output market, while the ratio of ϕ, the conjectural elasticity of supply, to ϵ shows the degree of market power exercised by the retailer as a lemon buyer. For each of the conjectural elasticities, a value of zero indicates perfect competition, while a value of one indicates monopoly or monopsony, respectively.

Equation (3) provides an expression for the retail-FOB margin in terms of the supply and demand elasticities, and the conjectural elasticities in the input and output markets. This expression allows a comparison of the relative size of the margin under the prorate and in an unregulated market. Rewriting (3) with the proportionate retail-FOB margin on the left-hand side gives

$$(4) \qquad M = \frac{P_r - MC_g}{P_r} = g\left(\frac{\phi}{\epsilon}\right) - \left(\frac{\theta}{\eta}\right) + k^*,$$

where $g = MC_g/P_r$ and $k^* = k/P_r$, and M is the retail-FOB margin. Under the prorate, assume that lemon sellers are able to exercise output market power, but cooperative control over lemon supplies prevents them from using any input market power. In the extreme case, this implies that $\theta = 1$ and $\phi = 0$, so the margin is equal to

$$(5) \qquad M_1 = -(1/\eta) + k^*,$$

or the elasticity of demand plus marketing costs.[3] However, if the loss of the marketing order represents a loss of handler control over pricing, then retailers maximize profit where their marginal revenue is equal to the marginal outlay on lemons, or $\theta = 1$ and $\phi = 1$. Consistent with Carman and Pick's (1988) observations of the suspension of the marketing order in 1985–86, this exercise of buyer power leads to wider retail-FOB margin:

$$(6) \qquad M_2 = (1/\epsilon) - (1/\eta) + k^*.$$

Of course, cases of monopsony, monopoly, or perfect competition are all extremes. In actuality, the values of θ and ϕ are more likely to lie somewhere between zero and one. In the following section, an econometric model is developed that estimates these parameters using monthly fresh lemon pricing data.

Empirical Model of Prorate Suspension

Retailers, through handlers or packers, choose the amount of lemons to purchase from growers and decide the spatial allocation between retail markets.[4] In doing so, a retailer's profit is equal to the sum of the revenue from each retail market's sales, less the amount paid for lemons, less the cost of marketing. The profit maximization problem is written above as equation (1).

Following Schroeter and Azzam (1991), the margin equation (4) is rewritten such that the retail-FOB margin is a function of marketing costs, exogenous variables, and output and input market power parameters:

$$(7) \qquad M_{it} = \frac{P_{r,it} - MC_g}{P_{r,it}} = \left(\frac{MC_g}{P_{r,it}}\right)\left(\frac{\phi}{\epsilon}\right) - \left(\frac{\theta}{\eta}\right) + \frac{C(w)}{P_{r,it}} + Z_{it},$$

where M_{it} is the proportional retail-FOB margin in region i and time period t; retailing costs, C, are a general function of labor and transport costs, w; and Z_{it} is a vector of exogenous variables that influence the proportional margin. However, as the discussion above indicates, the locus of power in the marketing channel is likely to change depending

[3] Where η is left as a negative value, this margin is positive.

[4] Note that, because the problem is cast from the perspective of lemon buyers, the empirical model need not consider the optimal allocation between the fresh and processed markets. Studies such as Powers (1993) deal adequately with this issue.

upon whether the prorate restrictions are effective or suspended.

Econometric estimates of the effect of market power on the retail-FOB margin take into account the different bargaining power relationships between the prorate and non-prorate periods. In terms of the empirical margin model, a binary variable, D_t, differentiates between the conjectural elasticities during each of the prorate regimes:

$$(8) \quad M_{it} = \frac{P_{r,it} - MC_g}{P_{r,it}} = \left(\frac{MC_g}{P_{r,it}}\right)\left(\frac{\phi}{\epsilon}\right) + D_t\left(\frac{MC_g}{P_{r,it}}\right)\left(\frac{\hat{\phi}}{\epsilon}\right) - \left(\frac{\theta}{\eta}\right) - D_t\left(\frac{\hat{\theta}}{\eta}\right) + \frac{C(w)}{P_{r,it}} + Z_{it},$$

where $D_t = 1$ during prorate periods, and $D_t = 0$ during suspensions. With this model, tests for the effect of prorate suspension on the exercise of market power, and hence marketing margin behavior, amount to tests of the equality of the conjectural elasticities between the suspension and non-suspension regimes.[5]

Identifying the conjectural elasticity values requires a multi-stage estimation procedure. Details are provided in several studies (e.g., Wann and Sexton; Schroeter and Azzam 1991; and Azzam and Pagoulatos, among others) on the framework for estimating marketing margins equations under imperfect competition. Specifically, the first stage estimates time-varying elasticities of demand and supply. Substituting these estimates into equation (8) identifies the conjectural elasticities of demand and supply. In the second stage, the marketing input cost function, $C(w)$, is specified as a dual retailer cost function to account for the effect of input price variation on the retail-FOB margin. The following discussion examines each of these steps in turn.

Empirical specification of the demand function closely follows Carman and Pick's (1988) model. This model treats weekly retail price as a function of per capita consumption, lagged real prices, income, grade, and seasonal dummy variables. Modifying their model to account for monthly data, the U.S. demand for fresh lemons is written in inverse form with the national average retail lemon price a function of the per capita quantity delivered (Q), the ratio of quantity to time (Q/T), per capita income (I), the lagged retail price (P_{t-1}), a dummy variable that takes a value of one during prorate periods (MO), the average size of lemons shipped during the marketing year ($QUAL$), and dummy variables for each month of the year, excluding December—which acts as the base, or reference month (MN_k). Although monthly price data are less likely to reflect lagged price adjustment, preliminary tests find strong support for the inclusion of lagged prices in these data as well. With this specification, the slope of the demand function varies with time as follows:

$$(9) \quad P_t = a_0 + a_1 Q + a_2 \frac{Q}{T} + a_3 I + a_4 P_{(t-1)} + a_5 MO + a_6 QUAL + \sum_{k=1}^{11} a_k MN_k + e_j.$$

Carman and Pick's model of lemon supply includes each of the factors the Lemon Administrative Committee considers when recommending weekly deliveries. Attempting to forecast the strength of demand in the current week, the LAC looks at recent price and sales trends, storage levels, seasonal demand patterns, and indications of future demand commitments. Because the current model uses monthly data, the set of explanatory variables differs from the weekly model of Carman and Pick, but reflects many of the same economic influences on supply. Namely, lemon deliveries are a function of the equivalent-on-tree price per box in Southern California (P_g) multiplied by a time trend, the level of lemon stocks (S), lagged sales (Q^s_{t-1}), and the fitted value of the prorate suspension variable ($\hat{L}$). Multiplying the lemon price by a time trend

[5] Note that Schroeter and Azzam's (1991) assumption of firm homogeneity applies equally in this case, so each of the conjectural elasticities in (6) is a weighted average over all of the firms in the industry.

creates the necessary time variation in supply elasticity.[6] Finally, the supply model incorporates a binary variable to account for the prorate suspension period. Given these considerations, the supply function appears as

$$(10)\quad Q_t^s = b_0 + b_1 P_{g,t} T + b_2 S_t + b_3 Q_{t-1}^s + b_4 \hat{L}_t + u_t.$$

Equation (10) includes the fitted value of the prorate suspension binary variable because the decision to suspend is hypothesized to be endogenous to lemon supply conditions.[7] Formally, the null hypothesis is that the suspension decision is exogenous, so rejecting the null supports the endogeneity of the suspension dummy. Kennedy's omitted variables version of Hausman's general specification test determines whether or not the prorate suspension decisions are endogenous. In order to simplify the description of the Hausman test, the explanatory variables of (10) are separated into sets of exogenous (X) and possibly endogenous (Y) variables. With this definition, Y consists of the prorate suspension dummy variable. In general notation, the supply equation simplifies to

$$(11)\quad Q_{sj} = X\beta_j + Y\gamma_j + Y^*\tau_j + w_j,$$

where Y^* is the vector of fitted prorate suspension values. A Wald statistic tests the joint null hypotheses that all elements of τ_j are equal to zero. Rejection of the null indicates that lemon prorate suspension decisions are indeed endogenous. If the suspension dummy is endogenous, then estimating (10) with D_t instead of $\hat{L}$ with ordinary least squares will result in biased and inconsistent parameter estimates as the binary variable is correlated with the equation residuals. Clearly, policy recommendations that result from inconsistent parameter estimates have the potential to be seriously in error.

To correct for this possible source of bias, the model incorporates Heckman's two-stage endogenous dummy-variable method. In this method, a first-stage probit model specifies the suspension binary variable as a function of current deliveries, prices in the previous month, and the level of lemon stocks, each as defined above. In the second stage, the fitted values from the probit regression are used as instruments for the binary variable in the supply equation. The resulting parameter estimates are consistent, and are used to calculate the price elasticity of supply. In addition to the market power measures, the margin equation also includes various measures of marketing cost.

Estimates of retailers' operating costs are dependent upon labor (W) and transportation costs (TR) for delivery to each region. Given that the actual form of the cost function is not known a priori, a generalized Leontief functional form is used which approximates an arbitrary cost function. Schroeter and Azzam (1991) detail the conditions and assumptions made in the estimation of a single cost function as an aggregation over all retailers. With these assumptions, the empirical specification of the cost function for each region j is

$$(12)\quad C_{j,t}(w_{j,t}) = c_{j0}W_t + c_{j1}TR_t + c_{j2}(W_t TR_t)^{1/2} + v_t.$$

Substituting the cost function (12) into equation (8), and adding a set of monthly binary variables completes the derivation of the margin model.

[6] Supply response studies for citrus crops find that the most important determinants of supply include long-run expected prices, current bearing acreage, the age of the existing grove, and proxies for urbanization, technological change, farm labor availability, and tax laws (Carman). Besides the price variable, most of these factors are either unobservable or unavailable on a monthly basis; therefore, they are usually proxied by a simple time trend.

[7] As pointed out by an anonymous reviewer, prorate suspensions only occur in periods of unusually low supply. Because the primary purpose of the prorate was to hold market deliveries below their unregulated levels, prorates were simply not required when supplies were limited due to poor harvests, or storage problems. Therefore, to accurately estimate the supply response of lemon shippers, the empirical model differentiates between prorate and non-prorate regimes. Further, by including those factors considered by the LAC in suspending the prorate in a separate probit regression, this analysis models, as well as possible, the characteristics of supply response in suspension periods as different from those under non-suspension periods.

In the margin specification, the prorate suspension dummy acts as a slope shifter on the market power measures. Estimating both the suspension and non-suspension conjectural elasticities provides a separate test for market power in each regime.[8] Including the retail cost function, monthly dummy variables, and a random error term, the retail-FOB margin for each region j (with the time subscript omitted) is given by the following:

$$(13)\quad \frac{(P_j - MC_g)}{P_j} = M_j$$

$$= c_{j0}\left(\frac{W_j}{P_j}\right) + c_{j1}\left(\frac{TR_j}{P_j}\right)$$

$$+ c_{j2}\left(\frac{(W_j TR_j)^{1/2}}{P_j}\right)$$

$$+ \left(\frac{\theta_j}{\eta_j}\right) + \hat{L}\left(\frac{\hat{\theta}_j}{\eta_j}\right)$$

$$+ \left(\frac{MC_{g,j}}{P_j}\right)\left(\frac{\phi_j}{\epsilon_j}\right)$$

$$+ \hat{L}\left(\frac{MC_{g,j}}{P_j}\right)\left(\frac{\hat{\phi}_j}{\epsilon_j}\right)$$

$$+ \sum_{k=1}^{4} c_{jk} MT_k + \mu_j,$$

where μ_j is normally distributed with zero mean and with a variance-covariance matrix given by

$$(14)\quad E(\mu_j \mu_j') = \sigma_{jj} I_M,$$

$$E(\mu_j \mu_m') = \sigma_{jm} I_m, \qquad \sigma_{jm} \neq 0,$$

and MT_k is the kth monthly dummy (July–October). Preliminary specifications of the model show that lagged margin values, incorporated to test for the slow adjustment of margins reported by Pick, Karrenbrock, and Carman, are insignificant determinants of current margins. Tests of the non-diagonality of the variance-covariance matrix indicate that the sample disturbances are contemporaneously correlated, so the set of equations is estimated with a seemingly unrelated regressions (SUR) procedure.

With this model, tests of the equality of the conjectural elasticity parameters between the prorate and non-prorate regimes determine the effect of lemon prorate suspension on retail-FOB margins. Specifically, if the output market conjectural elasticity is greater without prorates than with, then the retail-FOB margin will be greater without the prorate system. Similarly, for buyer market power, if the input market conjectural elasticity is greater without prorates, then margins widen in the absence of regulation.

Data

The U.S. Department of Labor/Bureau of Labor Statistics (USDL/BLS) consumer price index database provides monthly retail lemon price data for the four markets of New York, Chicago, Atlanta, and Los Angeles from August 1984 through December 1993. Regional personal disposable income data are also based upon BLS information. The data on regional monthly lemon arrivals in each of the above cities are found in the USDA's annual *Fresh Fruit and Vegetable Arrivals in Western (Eastern) Cities* publications. Grower prices are monthly average FOB prices to California packing houses from the USDA/ERS publication *Fruit and Tree Nuts: Situation and Outlook Yearbook,* which also provides the lemon stock data. Total monthly shipments and average quality values are taken from various issues of the *Annual Report of the Lemon Administrative Committee,* which, since the dissolution of the committee, are held by the USDA/Agricultural Marketing Service (USDA/AMS).

Proxies for the marketing cost variables include average hourly wages in food retailing (USDL/BLS) for each of the four regions, and the cost of transporting produce by truck from Southern California to each of the terminal markets. The latter data are available in the *Fruit and Vegetable Truck Rate and Cost Summary,* published by the Federal-State Market News Service of the USDA. Prorate sus-

[8] An example of a similar application of this procedure is found in Chang.

Table 1. Lemon Summary Statistics

Variable	Units	Mean	Variance	Minimum	Maximum
P^r_c	¢/lb.	38.18	37.51	28.73	51.76
P^r_s	¢/lb.	37.96	40.03	27.51	55.37
P^r_e	¢/lb.	37.19	47.00	25.92	55.97
P^r_w	¢/lb.	37.77	52.18	24.78	57.46
Q_c	000s cwt	68.49	368.14	30.00	128.00
Q_s	000s cwt	42.09	81.63	24.00	67.00
Q_e	000s cwt	108.76	1,554.30	38.00	220.00
Q_w	000s cwt	57.33	154.49	35.00	92.00
M_c		0.77	0.017	0.45	0.97
M_s		0.78	0.016	0.46	0.96
M_e		0.77	0.017	0.43	0.96
M_w		0.76	0.015	0.49	0.95
W_c	$/hr.	10.98	0.31	8.89	11.69
W_s	$/hr.	9.56	0.82	7.26	11.78
W_e	$/hr.	9.86	0.48	8.27	10.96
W_w	$/hr.	11.13	0.41	9.50	12.21

Note: Variables are defined as follows: P^r_i is the retail price in market i, Q_i is the amount of lemon deliveries to market i, M_i is the retail-FOB margin in market i, and W_i is the food-retailing wage rate in market i.

pension periods are given in various issues of the *Annual Report of the Lemon Administrative Committee.* Table 1 provides the descriptive statistics for the regional fresh lemon quantities, prices, margins, and packing costs.

Results and Discussion

The multi-stage empirical procedure begins by estimating the elasticities of supply and demand for lemons. In this section, we present and interpret the results from these equations first. A discussion of the marketing margin estimates follows.

Before estimating the supply curve, however, the results of the Hausman endogeneity test [equation (11)] are used to determine the form of the binary prorate suspension variable. The omitted variable test accepts the null hypothesis of exogeneity if the estimated parameter on the fitted value of the suspension dummy ($\hat{L}$) is not significantly different from zero. In fact, estimates of equation (11) show a t-statistic of 2.542 on the suspension parameter, so the test rejects exogeneity. As a result, estimates of the supply equation use Heckman's endogenous dummy variable procedure.

Stage one of Heckman's method requires estimating a probit model of the prorate suspension binary variable. Specifically, the probit model provides estimates of the regression model given by

$$(15)\quad \text{Prob}(D_t = 1) = \Phi(\alpha_0 + \alpha_1 Q_t + \alpha_2 P_{t-1} + \alpha_2 S_t),$$

where Φ is the normal distribution function, Q_t is the level of deliveries in month t, P_{t-1} is the FOB lemon price in the previous month, and S_t is the level of stocks in the current month.

The parameter estimates, marginal effects of each variable, and goodness-of-fit statistics resulting from this procedure are shown in table 2. Although not all of the explanatory variables contribute significantly to the decision to suspend prorates, the overall prediction success rate of 76.42% indicates the model effectively predicts administrative committee behavior. At a 5% level, only the total level of shipments and the level of lemon stocks are significant. Taken as a group, however, a likelihood ratio test rejects the null hypothesis that all the parameters of the probit model are jointly equal to zero. Specifically, with three degrees of freedom and a 5% significance level, the critical chi-square value is 7.815,

Table 2. Prorate Suspension Probit Model: CA/AZ Fresh Lemons (monthly, 1983–94)

Variable	Estimate[a]	Marginal[b]	t-Ratio
Constant	−6.0302	−2.3395	5.305**
Output	0.0055	0.0021	−1.861*
FOB Price$_{t-1}$	0.2683	0.1041	−1.401
Stocks	0.0002	0.0008	−4.718**
χ^2	46.934		

Notes: Single and double asterisks (*) indicate significance at the 5% and 1% levels, respectively. The chi-square test of all parameters = 0 at the 5% level with three degrees of freedom and a critical value of 7.815.

[a] Parameter estimates are maximum likelihood obtained with the probit function in LIMDEP.

[b] The marginal effects are given by: $\partial E(y)/\partial x = \phi(\beta' x)x$, where y is the dummy suspension variable, β is the parameter vector, and x is the vector of explanatory variables.

whereas the likelihood ratio test statistic is 46.934.

The marginal effect of each explanatory variable gives the expected change in the probability of observing a prorate suspension for a one-unit change in the value of the variable in question. For example, an increase in lemon shipments of 1,000 cwt causes the probability of suspension to rise by 0.2%. Although this result appears to be contrary to expectations, the model already accounts for the effect of a short supply on the suspension decision through the lagged FOB price. If the FOB price rises by one dollar per carton, then the probability of observing a suspension rises by 10.41%. The price effect also appears to outweigh the effect of lemon stocks. Commonly, low lemon stocks are felt to heavily influence the LAC decision to suspend the prorate, but the probit results suggest that price movements are more important. As explained in the following discussion, low demand elasticities contribute to the volatility of lemon prices.

Because the price and quantity are jointly determined in the demand equation (9), estimation uses a two-stage least squares procedure. The set of instruments consists of several variables that are felt to be correlated with both lemon shipments and retail price, but are exogenous to lemon demand, such as lagged values of lemon stocks, lagged lemon retail prices, average seasonal lemon size, the price of fresh oranges, the average U.S. retail wage rate, the average U.S. truck rate, per capita income, U.S. population, and a time trend. The aggregate fresh lemon inverse demand curve estimates are presented in table 3. At the sample mean price and quantity, these results imply a demand elasticity of −0.139, suggesting a highly price-inelastic demand for lemons. It

Table 3. Fresh Lemon Retail Demand Function: U.S. Per Capita Monthly Consumption (1984–93)

Variable	Estimate	t-Ratio	Variable	Estimate	t-Ratio
Constant	−37.702	−1.502	*March*	1.329	0.964
Quantity	−0.019	−2.118*	*April*	4.698	2.986**
Q/Time	−0.003	−0.370	*May*	6.644	2.267*
Prorate[a]	1.904	2.088*	*June*	7.293	2.896**
Income	1.883	2.593**	*July*	7.807	3.707**
Ret. Price$_{t-1}$	0.465	3.682**	*August*	3.346	2.739**
Quality[b]	0.368	2.063*	*September*	0.033	0.020
January	−2.062	−1.802*	*October*	0.721	0.576
February	−4.058	−3.545*	*November*	−1.452	−1.090
R^2	0.860				
D.W.	2.097				

Note: Single and double asterisks (*) indicate significance at the 5% and 1% levels, respectively.

[a] The *Prorate* variable is a binary variable that is equal to one during prorate periods, and is equal to zero during suspension periods.

[b] *Quality* is indicated by the average size of lemons shipped during the season.

is not surprising that lemon demand is inelastic, because of the relative unimportance of fresh lemons in consumer budgets and the virtual absence of viable substitutes.

Contrary to the navel orange results of Powers (1991b), retail prices are considerably higher during suspension periods than when the prorate is effective. The parameter estimate on the lagged lemon price is consistent with the finding of Pick, Karrenbrock, and Carman, who show that the retail price does not adjust instantaneously. Furthermore, the positive coefficient on the *QUALITY* variable suggests that smaller lemons (those with a higher count value) have higher retail prices. Just as the vector of time-varying demand elasticities identifies the conjectural elasticity of demand, estimates of the supply elasticity identify the degree of monopsony power.

Once again, the simultaneity of price and quantity in the supply equation requires an instrumental variables estimation method. Applying two-stage least squares to equation (10) provides estimates of the supply response of CA/AZ lemon growers. The assumption that one supply equation adequately describes lemon supply is appropriate given that California and Arizona supply over 90% of total domestic lemon consumption. With monthly data, lemon supply is defined in terms of grower deliveries rather than production. Production decisions are made at the time of planting, some five to seven years prior to harvest and delivery. The inclusion of the prorate suspension dummy models the LAC's tendency to recommend greater deliveries in high supply years in order to prevent stock buildups or the abandonment of fruit. The least squares estimates of the lemon supply equation are provided in table 4. These results show that lagged production, the ratio of the FOB price to time, and the level of stocks are all significant determinants of lemon supply. Although the elasticity varies over time, the average elasticity for the entire period is 0.46.

Substitution of the time-varying supply and demand elasticities into the margin equation identifies the conjectural elasticity parameters. In this context, conjectural elasticities show the percentage change in aggregate supply or demand for a given percentage change in retailer purchases or sales. Besides the market power parameters, the margin equation estimates the effect of marketing costs, the seasonality of margins, and the effect of prorate suspensions. Table 5 shows the margin equation parameters for each of the four geographic regions.

Table 4. Farm Supply Function: CA/AZ Fresh Lemons (monthly, 1983–94)

Variable	Estimate	*t*-Ratio
Constant	312.72	4.202**
Output$_{t-1}$	0.543	7.979**
FOB Price/Time	0.081	2.345*
Prorate[a]	23.966	0.573
Stocks	0.076	7.611**
R^2	0.748	
D.W.	2.045	

Note: Single and double asterisks (*) indicate significance at the 5% and 1% levels, respectively.

[a] See table 3 footnote for definition of the *Prorate* variable.

Tests for autocorrelation produce Durbin-Watson test statistic values for the North-Central, South, East, and West regions of 1.267, 1.420, 1.295, and 1.494, respectively. At the 5% level of significance, all but the West statistic lie below the lower-bound *d*-value of 1.434. Therefore, the parameter estimates in table 5 use the Prais and Winsten autocorrelation correction algorithm described in Greene.

Preliminary model estimates reject the partial-adjustment specification used by Pick, Karrenbrock, and Carman. Although margins appear to adjust slowly in their weekly data, the adjustment period is evidently less than one month, as such an adjustment becomes undetectable in the monthly data of this study. Several other factors do contribute to variation in the retail-FOB margin. Namely, table 5 shows that retail wages and transportation costs are significant components of the margin, and that margins tend to narrow during the months of July, August, September, and October compared to the excluded months.

The conjectural elasticity estimates show only limited evidence of selling power during

Table 5. SUR Estimates of Regional Lemon Retail-FOB Margins (monthly, 1983–94)

Variable	North-Central	South	East	West
W	−1.135	−1.463	−1.204	−1.005
	(−17.973)**	(−18.083)**	(−18.791)**	(−19.940)**
TR	−0.582	−5.705	−0.691	N.A.[a]
	(−0.068)	(−10.686)**	(−1.369)	
$(W \cdot TR)^{(1/2)}$	0.086	0.895	0.113	N.A.
	(0.580)	(9.404)**	(1.103)	
θ'	0.013	0.013	0.011	0.011
	(4.277)**	(4.450)**	(3.879)**	(3.739)**
ϕ'	0.002	−0.209	−0.018	0.049
	(0.017)	(−0.239)	(−0.144)	(0.396)
θ	0.133	0.096	0.132	0.134
	(14.225)**	(15.423)**	(16.487)**	(30.918)**
ϕ	0.239	0.249	0.326	0.240
	(2.135)*	(2.000)*	(3.067)**	(1.919)*
July	−0.052	−0.043	−0.047	−0.044
	(−3.294)	(−3.025)**	(−3.264)	(−3.202)**
August	−0.065	−0.058	−0.060	−0.059
	(−3.575)**	(−3.503)**	(−3.566)	(−3.562)**
September	−0.066	−0.060	−0.060	−0.052
	(−3.604)**	(−3.662)	(−3.568)	(−3.211)**
October	−0.043	−0.040	−0.037	−0.032
	(−2.819)**	(−2.980)**	(−2.622)	(−2.418)
R^2	0.805	0.738	0.632	0.759
N	97	97	97	97

Notes: Numbers in parentheses are *t*-ratios. Single and double asterisks (*) indicate significance at the 5% and 1% levels, respectively. The conjectural elasticity of demand is denoted by θ, and ϕ is the conjectural elasticity of supply. *TR* is the level of transportation costs from Southern California to each market, while *W* is the wage rate in food packing specific to the given region.

[a] Transportation costs for CA/AZ lemons are assumed to be zero for the West region, as Los Angeles prices are used.

prorate periods. Contrary to the navel orange results of Powers (1993), the Eastern, Southern, and North-Central lemon markets differ only slightly from perfect competition at the 5% level. The output market conjectural elasticities for these markets are small in an absolute sense, averaging slightly over 1% for each market, but are statistically quite significant. None of the regions provide evidence of input market, or buying power during the prorate regime. Under prorate suspension, however, all fresh lemon markets are imperfect on both the buying and selling side. With respect to the output market conjectural elasticities, estimates vary from 0.096 in the South to 0.134 in the West region. Input market power represents the largest influence on margins under prorate suspension, as expected based on both the arguments of Carman and Pick (1988), and the theoretical model of this study. Whereas the input market conjectural elasticities are not significantly different from zero under the prorate regime, they are significant in each market under prorate suspension. Estimates of these parameters vary from 0.239 in the North-Central region to 0.326 in the East. Given that their allowable range is from 0 to 1, these results suggest that margins rise by an average of almost 30% without the flow-to-market regulation of prorates. Clearly, prorate suspension has its greatest impact on margins through the exercise of monopsony buying power on the part of lemon distributors or retailers.

Likelihood ratio tests formally compare the output and input conjectural elasticities between the suspension and non-suspension regimes. The first test restricts the output market conjectural elasticities to be equal between the two regimes. Comparing the values of the log-likelihood function from this and an unrestricted model using a likelihood ratio test provides a chi-square distributed test statistic. With three degrees of freedom, the critical chi-square value is 7.815 at the 5% level of significance. The calculated likelihood ratio test statistic is 220.97, so the test clearly rejects the null hypothesis of parameter equality. A similar test of the equality of the input market conjectural elasticities produces a likelihood ratio value of 14.212. Again, this result indicates that lemon buyers exercise a greater degree of market power without the prorates in effect.

Although the lemon and orange markets are somewhat different, these market power results contradict those of Powers (1991b); Powers, Zepp, and Hoff; and Thor and Jesse for navel oranges, and the results of Carman and Pick (1988) for lemons. Each of these studies argues that suspension of the prorate leads to a larger allocation to the fresh market and lower retail prices. Wider margins under prorate suspension due to the exercise of monopsony and monopoly power mean that retailers sell fewer fresh lemons at higher retail prices. When the prorate is in effect, retailers show little success in taking advantage of the inherent inelasticity of demand because the amounts they sell are controlled by the LAC. However, in an unregulated market, retailers are free to sell any amount they choose. These results indicate it is in retailers' interests to limit the amount they sell and increase retail prices, irrespective of their ability to force the FOB price down. If retailers are unable to exercise buyer power due to the existence of a cooperative with countervailing market power, their only alternative is to increase profits through higher retail prices. This result would determine changes in the retail-FOB margin without prorates if cooperatives are able to continue in their present role.

However, these findings also show that, without the prorate, cooperatives are less able to influence the price paid at the packer level. As a result, lemon buyers are able to restrict their purchases and force the FOB price down—the standard monopsony-power result. Monopsony power becomes important because cooperatives in the lemon industry have open-membership policies; that is, they have no ability to control the amount that growers bring to the market. As such control is a necessary condition for the ability to countervail the use of buyer power, they are left somewhat powerless without their control of the LAC and its ability to regulate deliveries.

Conclusions

This study argues that the deregulation of fresh lemon sales resulting from the CA/AZ citrus marketing order termination is likely to significantly widen the retail-FOB margin. Whereas the prorate system enables lemon marketing cooperatives to limit the exercise of input and output market power by retailers, this power disappears without the prorate. The exercise of significant monopsony and, to a lesser extent, monopoly power by lemon retailers under prorate suspension results in a rise of the retail price and a decline in the FOB price. Clearly, this leads to wider retail-FOB margins—a result that benefits neither consumer nor producer interests.

Empirical estimates of a structural model of marketing margins support these conclusions. Regional, monthly fresh market margin data from 1984 through 1993 show the retail-FOB margin to be significantly wider during prorate suspension periods than when the marketing order controls fresh market allocations. In fact, input market power parameter estimates, which show the response of margins to changes in the elasticity of supply, increase by a factor of up to 10 times their non-suspension values.

Several factors influence the level of fresh lemon retail-FOB margins that have been previously ignored in the literature. First, the model treats the decision to suspend the prorate as endogenous to supply conditions in the lemon market. Heckman's endogenous dummy variable method corrects for the resulting simultaneity bias in estimating the supply elasticity when this consideration is not taken into account. Second, allowing buyer and seller market power to be determined by the policy regime represents a new way of looking at the effects of government-sanctioned marketing orders in produce markets. Contrary to much of the previous research in this area, the results of this study demonstrate that buyer market power does increase in the absence of the marketing order, and, in fact, becomes the dominant influence on margins.

There are many potential implications for the lemon industry. Cyclical overproduction and characteristic cycles of boom and bust in all citrus markets led to the establishment of the marketing order. Without the ability to regulate market flows, producers claim they will not be as willing to make long-term investments in new orchards. Such investment is likely to fall as a result of growers' smaller share of the retail dollar and the likely increase in the variability of lemon prices—an issue on which this study is silent. Any rise in price volatility will likely reinforce the reductions in orchard investment caused by lower margins. A reduction in new plantings, or an increase in orchard removals, will result in a supply reduction at a time of bright future prospects for international sales of both fresh and processing lemons.

Some argue that the long-run reduction in supply will lead, ultimately, to higher lemon prices. However, if the industry is to attain an equilibrium in the long run, a lower level of production will only be consistent with lower prices as the industry moves down its long-run aggregate supply curve.

These results also suggest that the cooperatives themselves may be harmed. One of the reasons given for the termination of the marketing order concerns allegations of "cheating" on the prorate regulations by both independent and some cooperative handlers. Without the prorate to enforce orderly marketing, the temporal and geographic dispersion of lemon deliveries results in ample opportunity for the cheaters to undercut the cooperative price openly and effectively. It is hoped that this study will serve to reopen the investigation of the effect of marketing orders in this and related produce markets.

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