Farm Price Estimation When There is Bargaining: The Case of Processed Fruit and Vegetables

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Raw product prices for many processed fruits and vegetables are determined in part as an outcome of negotiations between processors and farmer bargaining associations. In such cases, unique market equilibrium solutions may not exist. This study develops a framework for price prediction under bargaining and applies it to the California cling peach industry. The price prediction equation turns out to involve the same variables as would a model specified for perfect competition. Hence a mistaken assumption about the structure of competition may still provide a model that predicts well, provided the structure remains constant.

Key words: bargaining, demand, econometric model, peaches, prices.

Many U.S.-produced fruits and vegetables are marketed through farmer associations whose primary function is to bargain with processors over prices of the raw product and other terms of trade. In 1982 there were ten fruit and nineteen vegetable bargaining associations in the United States, eighteen of the twenty-nine located in the western states of California, Oregon, and Washington (Skinner). Because bargaining implies some type of oligopsony-oligopoly structure, derived grower-level demand functions may not exist for these commodities (as they do under perfect competition). Each processing firm may take account of how its procurement price is affected by the quantity purchased and possibly by the reactions of its rivals. Many behavioral specifications are possible. With the bargaining association simultaneously attempting to act as a cartel, it may be impossible to define unique equilibrium solutions for the raw product prices.[1] This presents a difficult problem for econometric modelers.

The objective of this paper is to develop a framework for specifying and estimating the structural components of a model that predicts the outcomes when there is a bargaining process. The empirical performance of the model is examined in an application to the California cling peach industry.

Bargaining Structure

Farmer bargaining associations are voluntary cooperatives organized to give individual farmers a greater voice and (hopefully) more power in dealing with what, for most commodities, is a relatively small number of processor buyers. These associations are a type of cartel that controls the disposition of the members' product but has no control over the quantity produced. Individual farmer members behave approximately as perfect competitors in production; i.e., they generally do not take account of the possible effect of their own output on the price received.

Bargaining associations operate in diverse ways. Most commonly, they do not take title to the raw product but they do require their

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[1] The case of bilateral oligopsony is not well developed in the literature. For a simple illustration of the problem in terms of monopsony and bilateral monopoly, see Miller, p. 371; Henderson and Quandt, pp. 222–26.

members to sign exclusive marketing agreements designating the association as the sole sales agent. A farmer may be free to sell to the processor of his/her choice provided the farmer conforms to the terms established by the bargaining association. However, bargaining associations deal only with private (noncooperative) processors (see Bunje for further description of bargaining processes). The share of individual-crop supply represented by bargaining associations varies widely among commodities and often from year to year, ranging from less than 10% to as much as 80% (see Skinner for greater detail).

Theoretical Foundations

The basic theoretical considerations involved in grower-processor bargaining for fruits and vegetables were laid out by Helmberger and Hoos about twenty years ago. Later, Ladd extended the Helmberger-Hoos analysis to provide a mathematical model of bargaining behavior under alternative objective functions and specifications; and Babb, Belden, and Saathoff analyzed the factors that affected outcomes in an actual bargaining situation. In a somewhat more historical and literary analysis, Bunje has described the strategies, tactics, and procedures of price negotiations based on his many years of experience as a bargaining association manager. Although the last three papers provide additional insights into the bargaining process and conditions for farmer success, the seminal work of Helmberger and Hoos provides the main foundations for the analysis to follow.

For analytical purposes it is useful to distinguish three types of bargaining situations: (*a*) processors behave as price takers while the bargaining association behaves as a cartel; (*b*) processor procurement is characterized by oligopsony, while the bargaining association behaves as a price taker; (*c*) processor procurement involves oligopsony, and at the same time the bargaining association attempts to act as a cartel.

Case I. Price-Taking Buyers—Cartel Sellers

Helmberger and Hoos noted that if there is pure competition in procurement, there is no basis for a bargaining process; the association would need merely announce its terms. In this case a price-prediction model may be obtained by specifying the derived farm-level demand function (which clearly exists in this case) and a function to describe the price-setting behavior of the association.[2]

Case II. Oligopsony Procurement—Price-Taking Sellers

In cases where the bargaining association is dominated by oligopsonistic processor buyers, there is no conceptual problem in specifying a supply relationship, but specifying a model to describe processor behavior presents substantial difficulties. Oligopsony embraces a broad class of market structures, and there are no generally accepted behavioral assumptions, particularly no universal assumptions concerning reactions of rivals.

Helmberger and Hoos approached the problem by treating the oligopsonists as a colluding monopsony with individual-firm marginal net revenue product curves horizontally summed to form an aggregate marginal net revenue product curve comparable to the marginal net revenue product curve of a monopsonist. The quantity of raw product purchased is then determined by the intersection of the aggregate marginal net revenue product curve and the marginal input cost curve, and the price is set according to the supply curve. The general applicability of the restrictive assumptions of this model might be questioned; but even if accepted, the model leaves us with the same problem as pure monopsony—i.e., it is not possible to define a unique relationship between farm price and quantity of raw product purchased.

A plausible (and more tractable) oligopsony model is that of dominant-firm price leadership. Applying this specification to the California processing tomato industry, Just and Chern showed that if supply behavior is competitive and the supply curve shifts in level only (slope constant), market observations of prices and quantities trace out what they called a "perceived" demand curve. This curve falls below the demand curve farmers would face

[2] Under competition, the input demand function for the raw farm product expresses quantity as a function of the price of the farm product, the prices of other inputs, and the expected price or prices of the processed products. The latter may be expressed as functions of observable variables such as quantity processed, carry-in stocks, population, income, and other demand shift variables. Substituting in the input demand function and aggregating then provides the farm-level demand function.

if processors behaved as perfect competitors. If the slope of the supply curve changes, the slope of the perceived demand curve changes.

The Just-Chern model establishes a structural relationship between farm price and quantity which can be estimated along with the supply function (simultaneously in the case of tomatoes) by using data for periods in which the slope of the supply curve and the price leadership practice remain unchanged. The perceived demand function is likely to include the same variables as would be included in a farm-level demand function under perfect competition in procurement and farm sales.

Case III. Bilateral Oligopsony-Oligopoly

In the case where both processors and the bargaining association attempt to act as price setters, the market equilibrium mechanism breaks down. Helmberger and Hoos show that, as in the case of bilateral monopoly, the best that can be done is to define a price-quantity space that will contain the final bargained-for price-quantity solution. The size of this subspace is influenced by the degree of competition among buyers; the greater the competition, the smaller the space.

The location of price within the bargaining space may be influenced on the grower side by bargaining tactics, share of industry volume represented by the cooperative, the price elasticities of demand and nonmember supply, legal protections, and environmental factors such as the degree of specialization and grower flexibility, including availability of alternative markets. On the processor side, the bargaining outcome may be affected by the extent of product diversification, geographic nature of operations, financial strength, and the extent of cooperative processing operations in the industry.[3]

[3] A reviewer of an earlier draft of this paper suggested that the theory of contestable markets developed by Baumol, Panzer, and Willig might be applicable to this case. The key characteristic of contestable markets is costless entry and exit. When such conditions exist, excess profits will be squeezed out and prices will be forced to the competitive norm, even under oligopoly. Growers can easily move in and out of a bargaining association, and entry and exit of new growers into the industry may involve relatively low costs. Hence, the grower market may be potentially contestable although with some lag caused by grower loyalties, uncertainties, and time required for new perennial crop production. Processing operations, on the other hand, involve high sunk costs. As pointed out by Spence, this gets in the way of hit-and-run entry, which is the cornerstone of contestable markets. It would appear then that contestable market theory has limited applicability in raw product markets that involve bargaining. This topic may, however, merit further study.

Case III presents a difficult problem for quantitative policy analysis or projection because some measure of the relation of farm price to output is usually required. A practical approach to this problem—and the one followed here—is to specify and estimate a function in which raw product price is the dependent variable and the explanatory variables are those which may influence the position of the space within which price bargaining occurs and the location of price within the bargaining space.

A Price-Prediction Model

The California cling peach industry appears to fall into the category of Case III, bilateral oligopsony-oligopoly. There are relatively few processors, and there is a long-established bargaining association. The remainder of this paper develops a farm-price-predicting equation appropriate for the specific conditions of this industry. However, extension or modification for other processed-commodity industries is straightforward.

Industry Characteristics

Clingstone peaches are the primary peach utilized for canning. They are produced only in California in significant quantities and are utilized almost exclusively for processing. The California Canning Peach Association (CCPA), often cited as one of the more successful farmer bargaining associations, has bargained with peach processors since before World War II. The share of industry tonnage represented by the association has fluctuated within a range of about 40% to 70%, but without any clear trend. Although the CCPA does not control all of the industry tonnage, its negotiations with processors tend to set the farm price (or at least the minimum price) for the entire industry (see Minami, French, and King, p. 11).

Because of declining markets, land allocated to cling peach production has decreased from a high of 85,000 total acres in 1968 to a little over 33,000 acres in 1984. The number of processing firms dropped from 15 in 1974 to only 8 in 1984. There is very little backward integration of processors into farming, but cooperative canners have processed an increasing share of industry tonnage. In spite of the major changes in industry size, the role of the CCPA appears to have remained relatively stable. Its market share and general bargaining procedures have not varied systematically. There have been some variations in strategy (e.g., use of sliding scale contracts that related price to industry volume in some years), but no great changes in relative market power and overall bargaining position are clearly evident.

The total supply of peaches potentially available for canning each year is predetermined by the amount of bearing acreage available for harvest and natural factors which affect yields. During most of the period from the 1950s to 1972, the quantity harvested and sold to canners was affected by various volume-control marketing-order programs (see Minami, French, and King). The CCPA had a substantial influence, through its member representatives, on the marketing-order policies pertaining to quantities surplused (not marketed) and this, in turn, affected grower prices. However, the surplusing decisions, accomplished mainly by "green-drop" requirements, were generally set prior to the completion of the CCPA price bargaining process. Therefore, the quantity sold to processors was essentially predetermined with respect to price, although in selected years this may not have held precisely.

Since 1972, the industry has operated without market controls, and the quantity purchased by canners has been essentially the quantity produced. The CCPA has obtained its bargaining strength from the potential threat of withholding from individual canners and from a provision in the California Agricultural Code which specifies that growers are entitled to "fair" prices. Failure to agree is subject to adjudication.[4] In 1981 the CCPA did affect the total quantity produced by paying for a voluntary tree removal incentive program which later influenced the level of the negotiated price. However, the removals were not directly a part of the negotiation process. Overall, total industry pack decisions have been dominated by the predetermined supply.

Model Specification

In the classical bilateral monopoly model, the upper limit of the bargaining range is defined by the marginal revenue product curve of the buyer—an expected function in the case of processed fruits and vegetables. Because the competitive structure in the processed-product market may be unclear, the maximum raw product price may be defined more generally as the expected FOB price for the processed product or products less the expected cost of transformation and storage, converted to raw product equivalents. The negotiated farm price then is the maximum price less an increment ($M \geq 0$) determined by the nature of competition in the processed-product market and the bargaining structure. That is,

$$(1) \qquad PF = C(EPP - EPC - M),$$

where PF is the raw product price, C is a fixed technical conversion ratio between the raw and processed product, EPP is the expected price of the processed product, and EPC is the expected processing and storage cost per unit of processed product excluding the raw product cost.

Under perfect competition in both sales and procurement, $M = 0$ except for possible risk discounting. If the processed-product market is imperfect, the upper limit of farm price is defined with respect to expected marginal revenue, so M may be greater than zero even if procurement is competitive. The value of M increases with increases in processor bargaining strength relative to that of the association. If several processed products were made from the single raw product, EPP and EPC would refer to a weighted average of prices and costs. The farm price prediction equation is determined by specifying the relation of EPP, EPC, and M to observable variables.

Expected FOB price and processing cost. Processors are assumed to behave rationally in the sense that they take account of a perceived supply and demand structure for the processed product when forming their price expectations. Their perceptions need not be precisely correct. The processor-level demand and supply structure for canned cling peaches (and other processed fruits and vegetables as well) consists of three types of jointly related equations: (*a*) the FOB demand function facing processors; (*b*) a function that sets the FOB price, with quantities not sold at that price carried to the next season; and (*c*) a carryover-stock identity. These functions pertain to the processed-product marketing year, which begins just before the harvest and processing sea-

[4] In at least one year the price was not finally established until after the canning season ended. It was settled by an outside arbitrator to avoid costly court battles.

son, June 1 for cling peaches. The raw-product price is normally established in the spring or early summer prior to the marketing year. It is assumed that the equations of this system may be approximated by linear functions with price-level and population changes incorporated by expressing all price and cost variables in deflated values and all quantities in U.S. per capita values.

The demand function (or functions) includes deflated marketing-year price (PPD_t) and per capita sales (QMN_t) as endogenous variables, plus other variables which processors may view as indicators of shifts in the level of per capita demand. The latter, designated by W for the moment, are treated as exogenous or predetermined.

A study by French and King suggests that cling peach processors tend to set the FOB prices at which they offer canned products to cover the processing cost per unit (PCD_t) plus the previously incurred cost of the raw product (PFD_t/C), with further modification based on the level of per capita seasonal supply (quantity packed plus stocks carried in, $QPN_t + SN_t$) and the current movement (QMN_t). They treat PCD_t as an exogenous variable, and PFD_t and $QPN_t + SN_t$ are predetermined with respect to the processed-product marketing year.

The third endogenous variable of the system, quantity carried out, is determined by the identity:

$$SN_{t+1} = QPN_t + SN_t - QMN_t.$$

The reduced-form equation for the FOB processed-product price obtained from this perceived simultaneous system is

$$(2)\ PPD_t = \alpha_0 + \alpha_1 PCD_t + \alpha_2 PFD_t + \alpha_3(QPN_t + SN_t) + \alpha_4 W_t + u_t,$$

where u is a random variable assumed to be distributed independently of the explanatory variables, and the other variables are as defined above. The variables on the right are all predetermined (known to processors) in the marketing year for the processed product. However, at the time the raw product price is established, stocks carried into the new year (SN_t), unit processing cost (PCD_t), and the level of demand (reflected by W) are not known. An expression for the expected processed-product price ($EPPD$) is obtained by specifying and inserting processor projection models for each of the variables whose values are unknown.

Because processed-product inventory levels are monitored frequently, the level of beginning stocks (on June 1 for peaches) can be projected accurately at the time of price bargaining. Therefore, SN_t may be regarded as known. The processing cost is likely to be projected closely from the value the previous year—i.e., projected $PCD_t = \phi PCD_{t-1} + e_t$ where e_t is a random variable.

Demand shifters, represented by W, normally would include factors such as personal income and prices of substitute commodities. In the case of cling peaches, however, the downward effects of changing consumer preferences tend to overwhelm all other shifters. Processor perceptions of such shifts are assumed to be captured by replacing W with lagged values of average per capita consumption, measured by a two-year average of combined per capita movement of canned peaches and fruit cocktail [$QTMN_2 = \frac{1}{2}(QTMN_{t-1} + QTMN_{t-2})$]. The supply of competing canned fruits was also included as a variable in an initial formulation but proved to be nonsignificant, probably because the final value of such supplies is uncertain at the time the cling peach price is established.

Beginning in 1974, all peach prices and costs moved abruptly to new levels that cannot be explained by the changes in the general price level or accounted for by changes in supply. A reasonable hypothesis is that it was a result of changed expectations associated with the beginning of double-digit inflation and a period of energy shortages. Similar shifts have been observed for a number of other canned fruit and vegetable commodities. The procedure used to reflect this shift was to introduce a dummy variable, $D74$, which has a value of zero for all years prior to 1974 and 1.0 thereafter. Variations which allowed the effect of the dummy shifter to decline over time were also considered, but they did not perform as well.

With these considerations, the expected FOB processed-product price may be expressed as

$$(3)\ EPPD_t = \alpha_0 + \alpha_1\phi PCD_{t-1} + \alpha_2 PFD_t + \alpha_3(QPN_t + SN_t) + \alpha_4 QTMN2_t + \alpha_5 D74 + (\alpha_1 e_t + u_t).$$

Determinants of M. M is a random variable whose mean value is determined by the underlying structural characteristics of the bargaining environment. Annual values may fluctuate around the mean as a result of variations in bargaining strategies and conditions. If processors are very competitive, M may be near zero. As processor power increases relative to bargaining association power, the value of M increases. Measurable factors associated with changes in relative bargaining strength could be the share of industry volume controlled by the bargaining association and the concentration of processors. In the case of cling peaches, it is possible that termination of the volume-control marketing-order program in 1972 could also have affected the mean value of M. However, an association of these particular measures with the farm price could not be detected. If the mean of M is stationary, it enters the farm-price-predicting equation only as a component of the intercept and the disturbance term.

It seems likely that M may also vary with the level of supply and previous-year processed-product prices and processing cost. When the seasonal supply is large M may decrease. Processors may be willing to settle for a lower margin per unit, while growers may tend to bargain more aggressively because of the lower prices associated with large supplies. When seasonal supplies are low, on the other hand, processors may attempt to achieve larger per-unit margins to cover fixed costs, while growers may bargain less aggressively since their price will be higher due to the reduced supply. Lagged processed-product price and cost reflect the processors *ex post* profit experience. When previous-year processor returns are relatively high, processors may be less resistant and growers more aggressive; the reverse might be expected when past processor returns are low.

Because supply and lagged cost also affect processed-product price expectations, their possible separate effects on M cannot be determined. But if the hypothesis is correct, the derivatives of supply and lagged cost on farm price will be reduced in absolute value since M is subtracted from the expected processed-product price.

The final price-predicting equation. Substituting equation (3) in (1) expressed in deflated values; replacing $EPCD_t$ with $\phi PCD_{t-1} + e_t$; assuming M to be at least potentially affected by $(QPN_t + SN_t)$, PPD_{t-1}, and PCD_{t-1}, and consolidating terms yields a linear function of the following general form:

$$(4)\ PFD_t = b_0 + b_1(QPN_t + SN_t) + b_2PPD_{t-1} + b_3PCD_{t-1} + b_4QTMN2_t + b_5D74 + v_t,$$

where v is a complex random variable. If QPN_t can be regarded as predetermined with respect to PFD_t (as in the case of cling peaches), equation (4) may be estimated as a single equation which predicts the price outcomes of the bargaining process. Where a raw product has alternative uses such as fresh, canned, or dried, or where contracts are signed at the time of planting as for most processed vegetables, QPN may be a current endogenous variable. This then requires specification of allocation or supply functions and joint estimation of (4) as part of a simultaneous system. The outcomes of the bargaining process would be predicted from the resulting reduced-form equation with respect to the raw product price.

Estimation Results

Equation (4) was estimated using data for the period 1956 to 1982 (26 observations because of the inclusion of lagged variables), with 1983 and 1984 observations used as a prediction test. The variables and units of measurement are defined in table 1. Because the quantity processed (QP) is considered essentially predetermined for cling peaches, the equation was estimated by single-equation procedures. Because of some indication of serial correlation in the disturbances, it was specified as first-order autoregressive and estimated by maximum likelihood. The estimation results are given in table 2.

Table 2 includes three variations on the basic model. Equation (*a*) is the linear model as given by equation (4). Equation (*b*) measures all variables except $D74$ in logs. This formulation is not strictly consistent with the result that would be obtained by substituting a logarithmic processed-product price-expectation function in equation (1) but is included as a simplified approximation of a nonlinear formulation. Equation (*c*) expresses prices and costs in logs of nominal values with the price level entered as a linear variable in logs. A model fully linear in all variables with prices and costs in nominal values was rejected because this form does not permit the effect of quantity on price to increase with increases in the general price level.

The coefficients of all of the equations have the theoretically expected signs and all are statistically highly significant. Measured in terms of deflated values, the R^2's for equations (*a*) and (*b*) are modest. However, if computed with respect to the wider variance of nominal prices, the R^2 values are much higher, as in equation (*c*).[5]

The last column of table 2 gives the root mean square errors (*RMSE*) with respect to prediction of nominal prices expressed in original (not logged) values. The similarity of the *RMSE*s and coefficient errors among equations suggests that it would be difficult to argue that one is inherently superior to the others. All provide good fits to the historical data and consistent coefficient estimates. The linear form shows slightly larger *t*-ratios but also a slightly larger *RMSE* in nominal terms.

The functions in table 2 indicate that, with other variables held constant, the negotiated farm price has decreased with increases in the annual total supply of peaches relative to population (*QPSN*), has increased with increases in previous year FOB canner price of canned peaches (*PPDL*), and has decreased with a measure of previous-year processing cost per case (*PCDL*). Equation (*a*) indicates that in 1974, the deflated farm price moved to a level about \$17.80 per ton above previous levels (with other variables constant). That impact was modified subsequently by decreases in the movement indicator, *QTMN*2, which reflects a downtrend in demand.

The magnitude of the coefficient for the lagged processing cost variable (*PCDL*) merits some special comment. Since the conversion ratio between raw and canned peaches is approximately fifty-three cases of twenty-four number 2½ cans per ton, if a change in processing cost with other variables constant were passed immediately to the farm price, the coefficient for *PCDL* would be near fifty-three rather than the value of approximately seventeen in equation (*a*). The lower figure appears to reflect two types of behavioral adjustments. First, lagged costs are an imperfect projector of actual processing costs, so processors respond only partially to an observed change in cost, especially since such costs may include a significant fixed component that need not be covered each year. Second, as indicated by the price-setting model used to derive the processed product expected price (*EPPD*), processors may compensate for increased processing cost by setting higher FOB prices for the processed product as well as lowering the farm price. However, increases in the actual FOB price lead to increases in the stocks carried over to the next period. This, along with the reduced movement at the higher FOB price, shifts the bargaining range downward the next year and so reduces farm price. Eventually, the system adjusts so that the full impact of a change in processing cost, with other variables constant, is reflected in the farm price; but it is a dynamic process rather than an instantaneous adjustment.

Table 1. Variable Identification

Variable	Definition
PFD	California farm price of cling peaches, dollars per ton, deflated by the personal consumption expenditure deflator (*PCE* = 1.0 in 1967)
PPD	FOB processor price per case of 24 no. 2½ can peaches, deflated, crop year, 1 June–31 May
PCD	Representative average processing cost per case of 24 no. 2½ can peaches, deflated
N	U.S. total population, 1 July millions
QP	No. 1 quality peaches sold to processors, tons
QPN	$QP \div N$
S	Carry-in stocks of canned peaches and fruit cocktail on 1 June farm weight equivalent, tons
SN	$S \div N$
QPSN	Total supply, tons per million U.S. population (*QPN* + *SN*)
QTMN	Annual total crop-year movement of canned peaches and fruit cocktail, cases of 24 no. 2½ cans per thousand U.S. population
*QTMN*2	$\frac{1}{2}(QTMN_{t-1} - QTMN_{t-2})$
*D*74	Shift variable, *D* = 0 from 1957 to 1973, 1.0 from 1974 on

Note: The data series used in the analysis and descriptions of data sources are available from the author.

The final test of the model is not how well it explains the past but how well it predicts beyond the data set. A poor prediction may indicate a weakness of the model or reveal some change in structure not accounted for by variations in the explanatory variables. A limited test is provided by utilizing the equations estimated with 1957–82 data to predict farm prices for 1983 and 1984. The predicted and actual values are compared in table 3.

[5] Note that the prediction form for equation (*a*) is

$$PFD_t = b_0(1 - \rho) + \rho PFD_{t-1} + b_1(QSPN_t - \rho QSPN_{t-1}) + b_2(PPDL_t - \rho PPDL_{t-1}) + b_3(PCDL_t - \rho PCDL_{t-1}) + b_4(QTMN2_t - \rho QTMN2_{t-1}) + b_5(D74_t - \rho D74_{t-1})$$

and similarly for equations (*b*) and (*c*). The *b*'s refer to the coefficients given in the table.

Table 2. Estimation Results

Dependent Variable	Constant Term	Explanatory Variables[a]							R^2	D.W.	S	*RMSE*
(a) *PFD*		*QSPN*	*PPDL*[b]	*PCDL*	*QTMN2*	*D74*		Rho				
	68.3654	−.00993	11.7312	−17.2219	.2695	17.4882		.3127	.666	1.72	4.54	5.42
	(32.3231)	(.00300)	(2.7338)	(4.4938)	(.1028)	(4.1990)		(.2084)				
	2.12	−3.31	4.29	−3.83	2.62	4.16		1.50				
(b) ln *PFD*		ln *QSPN*	ln *PPDL*	ln *PCDL*	ln *QTMN2*	*D74*		Rho				
	4.4663	−.5074	.9237	−1.0582	.7559	.2219		.3011	.626	1.72	.0645	5.36
	(1.6351)	(.1584)	(.2269)	(.3219)	(.2814)	(.0595)		(.2090)				
	2.73	−3.20	4.07	−3.29	2.68	3.75		1.44				
(c) ln *PF*		ln *QSPN*	ln *PPL*	ln *PCL*	ln *QTMN2*	*D74*	ln *PCE*	Rho				
	3.9279	−.5011	1.0598	−1.1928	.8425	.1804	1.2224	.2622	.977	1.73	.0657	5.27
	(1.8730)	(.1621)	(.3699)	(.3749)	(.3246)	(.0888)	(.2970)	(.2164)				
	2.10	−3.09	2.86	−3.18	2.60	2.02	4.12	1.21				

Note: See table 1 for variable definitions. Equations estimated by maximum likelihood iterative technique, 1957–82 data, 26 observations.

[a] Values in the first row are regression coefficients. Values in parentheses are standard errors. Values below are t-ratios. Rho is the first-order autocorrelation coefficient. R^2 refers to the prediction of the untransformed dependent variable. R^2 values based on the Rho-transformed variables are .75, .94, and .97. D.W. is the Durbin-Watson statistic. S is the standard error of the regression. *RMSE* is the root mean square error with respect to the prediction of actual (not logged) prices in nominal values.

[b] L indicates lagged value ($t - 1$).

Table 3. Price Prediction Comparisons for 1983 and 1984

Equation and Year	Deflated Values[a]				Nominal Values[a]		
	PFD	PFD_p	$PFD - PFD_p$	SF[b]	*PF*	PF_p	$PF - PF_p$
	(1)	(2)					
(*a*) 1983	61.83[c]	73.30	−11.47	5.75	162.0[c]	192.0	−30.0
1984	67.58	75.87	−8.29	6.45	183.0	205.6	−22.6
	ln *PFD*	$(\ln PFD)_p$	$\ln PFD - (\ln PFD)_p$		*PF*	PF_p	$PF - PF_p$
(*b*) 1983	4.1243	4.3437	−.2194	.0928	162.0	201.7	−39.7
1984	4.2133	4.3046	−.0901	.1034	183.0	200.6	−17.6
	ln *PF*	$(\ln PF)_p$	$\ln PF - (\ln PF)_p$		*PF*	PF_p	$PF - PF_p$
(*c*) 1983	5.0876	5.2905	−.2029	.0937	162.0[b]	198.4	−36.4
1984	5.2095	5.2954	−.0859	.1031	183.0	199.4	−16.4

[a] *p* subscript indicates a predicted value.
[b] Standard error of forecast. Computed by adding dummy indicators (0–1) for 1983 and 1984 as suggested by Salkever.
[c] In 1983 the California Crop Reporting Service reported a farm price of $162 per ton ($61.83 deflated), while the CCPA reported a price of $148 per ton ($56.40 deflated). In other years CCPA and CCRS prices were nearly identical.

It should be noted first that 1983 was extremely unusual with respect to weather. Crop forecasts at the time CCPA prices were established were much higher than actually realized, and there were uncommon quality variations. In a telephone conversation, one industry representative remarked that "1983 was so unusual that it should be thrown out for all comparative purposes." The CCPA reported an average farm price of $148 per ton, while the California Crop Reporting Service reported an average farm price of $162 per ton. In most other years the CCPA and CCRS prices were nearly identical.

Table 3 indicates that in 1983, even using the higher CCRS value of $162 per ton, all equations substantially overpredict the farm price. The 1984 price predictions are closer, falling within about one standard error of the forecast. Overall, while the model clearly predicts too high a price in both years, the predictions are within the probability range of past errors.[6] However, it is possible that the deviations may reflect a more permanent structural shift. Following a period in which several processing firms left the industry because of low returns, the remaining firms may strive for more profitable margins. Another factor not explicitly considered in the 1984 prediction was the first flow of imported peaches into the United States beginning in 1983. The quantity did not reach significant proportions until 1984, then affecting the 1985 farm price prediction. The variable *QTMN*2, representing trends in past movement, includes exports; and it is possible that future predictions might be improved by treating imports as negative exports.[7]

Summary Comments

The results of this study demonstrate that it is possible to obtain consistent estimates of the relationship between farm price and quantity of raw product produced and sold to processors even though the market structure is such that a farm-level demand function cannot be defined. Prediction under a bargaining structure seems likely to involve a greater variance than might be expected when markets are competitive; but, for cling peaches at least, the coefficients of the important explanatory variables of the price-predicting equation were large relative to their standard errors. Such farm price predictions are essential for policy analysis and economic projections.

[6] Referring to equations (*b*) and (*c*), it is well known that predictions of original values are biased when the dependent variable is in logs. Kennedy suggests a correction for such bias but with some possible increase of mean square error. No correction was made here.

[7] In assessing how well a model predicts, it may be of interest to ascertain not only the nature of the actual deviations but how well it predicts relative to alternative time-series forecasting models. To that end, an autoregressive moving average model (ARMA, 1, 1) was estimated for the deflated farm price series. The historical *RMSE* for the ARMA model was well above the *RMSE* values in table 2, although the predictions for 1983 and 1984 were similar to those obtained with the structural model. Since the time-series analysis predicted no better and lacks a clear economic foundation and interpretation, that approach was rejected.

It may be observed that the price-predicting equation involves essentially the same variables as would be included under the assumption of perfect competition. This suggests that precise identification of the competitive structure may not be required if the primary focus is on estimating a relationship between farm price and output. That is, if the structure remains constant, the estimated function may provide consistent predictions even if the market is incorrectly assumed to be competitive, and vice versa. This may be quite important because it is often very difficult to obtain a clear indication of the specific nature and extent of imperfectly competitive behavior from the limited information available. Of course, if the competitive structure changes, the estimated price-predicting equation may no longer be valid since both the slope and level of the function may be affected.

The virtue of generality for price prediction purposes may also be a limitation for other purposes. Although the model is applicable to an imperfectly competitive bargaining structure, it does not provide a basis for distinguishing whether a particular structure is, in fact, competitive or noncompetitive. Such determination requires additional and more detailed data pertaining to individual firm costs and pricing practices.

It should be noted, finally, that analysis of the full impact of a policy that would affect quantity produced may require a dynamic model of the total commodity system not just a single-period price prediction equation.

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