Demand and Price-Markup Functions for Canned Cling Peaches and Fruit Cocktail

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This study formulates and estimates a six-equation model for canned cling peaches and fruit cocktail in which processors are viewed as price setters, with quantities not sold at the set price carried over to the next year. The system consists of two price-markup equations, two quantity-dependent demand equations and two inventory change identities. The three-stage least squares estimation results tend to support the behavioral hypotheses.

Key words: demand, fruit cocktail, peaches, price markup, simultaneous equations.

Most processed fruit and vegetable commodities are processed within a relatively short harvest season and placed in storage for later distribution. The current pack plus any inventories carried from the previous year constitute a fixed crop-year supply which cannot be increased until the next harvest period. Processors have the option of selling the entire supply during the current year or, depending on market conditions, carrying some portion over to the next season. Because of this option, the quantities actually sold during the current market period and the FOB price received by processors are, in general, jointly determined.

The manner in which such systems are specified for purposes of empirical analysis depends on the assumptions concerning the behavior of processors. Most studies have either explicitly or implicitly treated processors as price takers whose only decision is how much of the available total supply to allocate to current period sales. The market allocation decision (short-run supply) is modeled by expressing annual quantity sold as a function of the available total supply, current price, and perhaps some measure of expected future price. Demand then is expressed with annual average price received by processors as the normalized variable in a function that includes annual quantity sold, income, and other demand shifters (Kuznets; Droze and Reed; Brandt and French; Minami, French, and King; French and Matsumoto).[1] The demand and allocation equations, plus an inventory identity (stocks carried over equal beginning stocks plus pack less sales) form a simultaneous system which may be estimated by appropriate systems methodology.

While the modeling approach described above is appropriate for perfectly competitive industries, many processed fruit and vegetable commodities are produced by only a few firms, frequently dominated by a major firm that acts as a price leader. In such cases, processor decisions may be more price oriented than quantity oriented. The price-setting behavioral hypothesis is further supported by the common canner practice of "listing" the prices at which they will sell their various products. The list prices often remain constant over long periods. Actual transaction prices may at times differ from the list prices, but the practice is suggestive of the firms' basic orientation. This suggests an alternative modeling approach in which the market-allocation equation is replaced by a price-setting equation and in which quantity is the normalized variable in the demand function.

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[1] The studies by Kuznets and Droge and Reed focused only on the demand component and implicitly assumed that quantities sold are predetermined by the available supply. Hence, they used a single-equation approach.

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The California canned peach industry appears to fall into the category of imperfectly competitive structures for which the price-oriented model may be appropriate. This paper describes and evaluates an application of that approach to the estimation of the demand and pricing system for canned peaches and fruit cocktail, the principal processed peach products.

Background Information

The clingstone peach is the primary peach used for canning. Small quantities of freestone peaches are also canned, but the amount has declined to less than 5% of the pack in recent years. Cling peaches are grown almost exclusively in California, and 95% of the crop is canned. On the average, roughly three-fourths of the fruit has been converted to "regular packs" of canned peaches. Another 20% has been used for fruit cocktail, with the balance used for miscellaneous items such as spiced peaches or fruit salad.

In the early 1960s, 18% to 25% of canned peaches and about 20% of fruit cocktail were exported. In the 1980s exports declined to 5% to 12% of canned peaches and 12% to 19% of fruit cocktail movement. There were no reported imports during the period of analysis. However, imports increased to significant proportions in 1984 and 1985.

Both regular pack peaches and fruit cocktail are processed into a variety of can sizes and pack styles (e.g., nos. 303, 2½, 10 cans; heavy syrup, light syrup). Because it is extremely difficult to deal econometrically with such detail, quantities in various can sizes are expressed in standard equivalent units (cases of 24 no. 2½ cans) and aggregated over all sizes and styles. The price for a single can size (no. 2½) is used as a representative measure of movements in the set of commodity prices.

The annual supply of peaches potentially available for canning is predetermined by existing acreage and natural factors affecting yields. Quantities of peaches actually processed have been affected historically by volume-control marketing order programs (terminated in 1972), and the price paid to farmers for the raw product is influenced by a grower bargaining association. However, these factors have no direct bearing on the present analysis. The outcomes of any market restrictions and bargaining negotiations are determined prior to the market period for the canned product and hence are predetermined variables with respect to this component of industry analysis.

In 1984, peaches were processed by eight canners and one freezer. Two of the canners were cooperatives. Cooperative canners are estimated currently to account for more than half of the pack. Much of their pack is under buyers' labels. The national brand canners are believed to act as price leaders.

Conceptual Framework

Processors are hypothesized to set initial FOB prices at the beginning of the marketing year so as to cover previously incurred processing and raw product costs and, subject to the cost considerations, to achieve the highest possible expected profit per case, given the supply to be moved, expected demand conditions, and the cost of carrying inventories to the next year. The practice of pricing to cover cost (at least variable cost) is suggested by observations that increases or decreases in raw product prices tend to be transmitted currently to the FOB prices (see data set in appendix 1). This could be due to the accuracy with which processors are able to forecast future canned product market conditions at the time the farm price is established.[2] However, in view of the wide fluctuations in inventory carryover levels, it seems unlikely that they are quite so omniscient.

The initial target profit margin per case is influenced by the total supply relative to expected market demand. Factors affecting market expectations include the supply of competing canned fruits and the level of carry-in stocks relative to the previous year total supply (i.e., the proportion of the previous year supply not sold). Carry-in stocks, which are a component of total supply, may have a separate influence on the price set because they are a major cost item to canners and a key indicator of market conditions.

As the market year progresses, canners may discover that product movement exceeds or falls below their original expectations and, therefore, may make some adjustment in the price quotations. Hence, the final average an-

[2] For cooperative members, the final price may be influenced by the later returns from processed sales.

nual FOB processor price is influenced by current movement (an endogenous variable) as well as the predetermined supply variables.

With these considerations, the price-setting equations, hereafter referred to as price-markup equations, express the crop-year average FOB processor prices per case of canned peaches and fruit cocktail as functions of the sum of processing and raw product cost per case, the total supply (pack plus carry-in stocks), the proportion of the previous year supply carried over, the total supply of competing canned fruit, total movement (endogenous), U.S. population (to account for changes in market size), and unexplained disturbances.

Demand functions facing processors of both regular pack and fruit cocktail may be grouped into three categories: (*a*) the U.S. domestic market demand, (*b*) export market demand, and (*c*) U.S. federal government demand. The total annual domestic consumption (U.S. purchases from canners) is a function of the FOB processor prices for canned products, population, income, prices of competing products, price level, marketing costs, and changing consumer tastes and habits. The export demand (sales to foreign countries) is a function of the FOB prices, exchange rates, and a wide variety of exogenous factors that affect the level of foreign demand. U.S. government purchases are made primarily for the military and government institutions and to support activities such as the school lunch program. Such purchases are also a function of FOB prices and of variable government policy.

Data pertaining to export and government demand shifters required to obtain separate estimates of the three jointly related demand functions could not be obtained. Therefore the three equations were summed into a single function in which the effects of export demand shifters and government policy are imbedded as components of trend variables and the disturbance terms.[3] The aggregated demand equations express current year movement as functions of FOB processor prices of canned peaches, fruit cocktail and competing fruits, total disposable income, population, an index of distribution costs, and some structural shifts to be discussed in the section on empirical specifications.

Empirical Specifications

The symbols used to identify the variables in the analysis are given in table 1. The data series used to estimate the equation system are presented in appendix 1. Appendix 2 describes the data sources.

Equation Forms

The empirical model expresses all equations as linear in variables where all prices and monetary variables are in natural logs of nominal values and all quantities are in logs of per capita values (scaled to per 1,000 population). While it is common practice to deflate monetary variables by some price level index, that specification seems inappropriate for the price-markup equations. Under the behavioral hypothesis of this model, the FOB processor price is related to the processing and raw product cost and hence is only indirectly affected by the general level of prices. On the demand side, when the quantity-dependent demand functions are expressed in logs, deflated and nominal form equations differ only by the constraints imposed on the way in which the income and price-level variables affect consumption. Hence there may be little difference in the price elasticity estimates.[4] Expressing all quantities and income on a U.S. per capita basis is an imprecise specification with respect to the export component of demand since the latter is not affected by U.S. population. However, exports have been relatively small, and

[3] Government purchases are relatively minor and have varied somewhat randomly over time, so little is lost by combining them with the total U.S. demand. One means of attempting to obtain a separate estimate of the U.S. domestic demand function is to treat exports as an exogenous variable. However, this appears to be an improper specification since disturbances in the domestic demand affect the price set and this affects exports, which in turn affects quantities allocated to the U.S. market. A model which ignored the simultaneity (treated exports as exogenous) yielded estimates that were biased downward and of lower and uncertain statistical significance.

[4] Estimates based on an alternative model that deflated demand prices and income by the Personal Consumption Expenditure price deflator yielded similar values for price elasticities and similar levels of statistical significance. However, using deflated values in the price-markup equations resulted in less plausible coefficients, lowered statistical significance, and introduced some serial correlation into the disturbance structure. The model expressed in log form (percentage changes) also gave better predictions for two years beyond the data set (predictions discussed in the evaluation section of the paper). A model in which the prices and income in the demand equations were deflated, but with the price-markup equations as in the model presented, also gave demand elasticities and price-markup coefficients similar to those presented. Because the results were similar, the simpler model was adopted.

Table 1. Symbol and Composite Variable Definitions

Variable	Definition
PPR	FOB processor price per case of peaches
PPF	FOB processor price per case of fruit cocktail
PF	Price paid to farmers for cling peaches, dollars per ton
RR	Cases of canned peaches per ton of raw product
RF	Cases of fruit cocktail per ton of raw product
RPCR	Raw product cost per case of canned peaches ($PF \div RR$)
RPCF	Raw product cost per case of fruit cocktail ($PF \div RF$)
PCR	Representative average processing cost per case of peaches
PCF	Representative average processing cost per case of fruit cocktail
TCR	Total peach cost per case ($PCR + RPCR$)
TCF	Total fruit cocktail cost per case ($PCF + RPCF$)
QPR	Cases of regular pack peaches, millions
QPF	Cases of fruit cocktail, millions
SPR	Carry-in stocks of canned peaches on June 1, millions
SPF	Carry-in stocks of fruit cocktail on June 1, millions
TSR	Total supply of regular pack peaches, 1,000 cases ($QPR + SPR$)
TSF	Total supply of fruit cocktail, 1,000 cases ($QPF + SPF$)
QMR	Total annual sales of canned peaches, 1,000 cases
QMF	Total annual sales of fruit cocktail, 1,000 cases
RSR	$TSR \div QMR$
RFR	$TSF \div QMF$
TSC	Total supply of canned apricots, pears and freestone peaches, million cases
QCRN	$(TSC + TSF) \div N$
QCFN	$(TSC + TSR) \div N$
IRR	$SPR_t \div TSR_{t-1}$
IRF	$SPF_t \div TSF_{t-1}$
QMRN	Annual sales of canned peaches, cases per 1,000 U.S. population
QMFN	Annual sales of fruit cocktail, cases per 1,000 U.S. population
TSRN	Total supply of canned peaches, cases per 1,000 U.S. population ($TSR \div N$)
TSFN	Total supply of fruit cocktail, cases per 1,000 U.S. population ($TSF \div N$)
N	U.S. total population, July 1, million
*D*74	Shift variable, $D = 0$ from 1956 to 1973, 1.0 from 1974 on
TDIN	Index of total U.S. disposable income per capita, calendar year corresponding to the crop year, 1967 = 1.0
*D*70	Shift variable, $D70 = 0$ from 1956 to 1969, 1.0 from 1970 on
T	Trend variable, $T = 1$ in 1956
*T*14	Trend variable, $T14 = 0$ from 1956 to 1969, *T* minus 14 from 1970 on
us	Disturbance terms

Note: Unless otherwise noted, all prices and quantity variables are per equivalent case of 24 no. 2½ cans.

such treatment greatly simplifies the analysis without appearing to introduce any serious specification error.

Demand Variables

A major challenge involved in estimating the demand functions for cling peaches and fruit cocktail is to account for difficult-to-measure shifts in the structure of demand, primarily beginning in the early 1970s. To gain a better insight into the nature of these shifts, OLS demand functions were first estimated for the period 1956–69. The per capita demand appeared stable during this period with no evidence of shifts not accounted for by changes in purchasing power (income and price level) (see Minami, French, and King). The 1956–69 equations then were used with 1970–82 prices and income to calculate predicted per capita consumption for the 1970–82 period, and the deviations from actual values were plotted and examined. Three major kinds of shifts seemed evident.

First, following the U.S. government ban on the use of cyclamates in diet foods in 1970, there was a clear drop in per capita sales at a given price. Some canners had established substantial markets for sugar-free canned peaches and fruit cocktail. The cyclamate ban, in addition to causing losses for canners with large inventories, wiped out for some years what had been a developing market.

Second, large increases in FOB processor prices associated with the accelerated inflation rates and the energy shortages which began about 1974 were initially accompanied by relatively small changes in per capita sales. It seems plausible that the new inflationary psychology altered consumers' willingness to pay. Hence there was, in effect, a temporary upward shift in the level of demand in terms of nominal prices.

Finally, it appeared that in spite of the upward shift in pricing structure beginning in 1974, an overall downtrend in demand for canned fruit continued, possibly modified to some degree by a partial recovery of the low-calorie market. There has also been some further loss of export sales.

The procedure used to try to account for the effects of these complex structural changes was to include a dummy variable (*D*70), which is zero prior to 1970 and then is 1.0 thereafter, and a quadratic trend variable that begins in

1970. The dummy variable allows for an immediate decline due to the cyclamate ban in 1970, while the quadratic trend variable is an attempt to reflect the combined influence of the several structural forces acting on the market since 1970.

Although both own-price and prices of competing products are included in the demand functions, it turned out that these prices have moved so close ($r = .99+$) that it was not possible to measure the substitution effects. Therefore, as a practical matter competing product prices were deleted. This seems unlikely to have much affect on the forecasting potential of the models. Such close movement among prices is inherent in the price-setting behavioral hypothesis because the prices are affected by many common variables. Hence, the close association observed historically may be expected to continue. A distribution cost index, *DCI*, was also deleted in the final empirical analysis because its high correlation with per capita income growth made it impossible to obtain statistically significant estimates of the cost parameter.

With the considerations noted above, the demand equations to be estimated were specified to have the following form:

$$(1) \quad \ln QMRN = b_{10} + b_{11}\ln PPR + b_{12}\ln TDIN + b_{13}D70 + b_{14}T14 + b_{15}(T14)^2 + u_1$$

$$(2) \quad \ln QMFN = b_{20} + b_{21}\ln PPF + b_{22}\ln TDIN + b_{23}D70 + b_{24}T14 + b_{25}(T14)^2 + u_2$$

where the price and quantity variables are current crop-year values. The variable definitions are given in table 1. We would, of course, expect b_{11} and b_{21} to be negative and b_{12} and b_{22} to be positive, although the latter may reflect time-related shifts not directly related to real income. An alternative specification which permitted the coefficients b_{11} and b_{21} to vary over time yielded implausible results and hence was discarded. The coefficients for $D70$ are expected to be negative, reflecting in part the initial impact of the ban on the use of cyclamates. The signs of the coefficients of $T14$ and $(T14)^2$ are not directly predictable, but would be expected to reflect a downtrend in recent years.

Price-Markup Variables

The processing cost measures used in the price-markup equations (*PCR* and *PCF*) were obtained from a report by an accounting firm which compiles standardized costs for a sample of processing plants. While these data are suggestive of general cost movements, they are not necessarily a reflection of "true" industry costs. Some indication of this is found in the fact that the reported FOB price for canned peaches was below the combined raw product and estimated processing cost during most of the period of analysis, although the price was above variable cost per case (see appendix 1). Fruit cocktail prices were generally above the estimated costs through 1974 but were below after that time. Also, in 1974 the level of *PCR* and *PCF* increased sharply—much more than the FOB prices and much more than can be explained by price-level changes. The values then continued to increase but more slowly than price-level indexes. The shift in 1974 may reflect, in part, a change in the nature of the sample or the method of accounting.

Possible explanations for the persistence of prices below these estimated costs are the following: (*a*) the cost and price series are for a particular container size, but canners pack in a wide variety of sizes and styles; (*b*) our price series pertain to private label sales, whereas national brand prices tend to be 10% to 15% higher per case; and (*c*) some plants were not covering replacement costs and in fact have gradually left the industry.

To account for the seeming peculiarities in the cost series, it was assumed that "true" processing plus raw product costs, TCR^* and TCF^*, can be expressed as functions of the sample cost measures, a dummy variable to account for the shift starting in 1974 and a trend variable; that is,

$$\ln TCR^* = a_{10} + a_{11}\ln TCR + a_{12}(D74)\ln TCR + a_{13}D74 + a_{14}T$$

$$\ln TCF^* = a_{20} + a_{21}\ln TCF + a_{22}(D74)\ln TCF + a_{23}D74 + a_{24}T.$$

The variables on the right then are substituted for TCR^* and TCF^* in the price-markup equations. The cross-product terms, $(D74)\ln TCR$ and $(D74)\ln TCF$, allow for the possibility that both the level of true processing cost and the relation to *TCR* and *TCF* may have shifted beginning in 1974.

In the price-markup equation for fruit cocktail, the farm price of Bartlett pears (and to a lesser extent, grapes and cherries) is also a factor in determining the FOB price. However, the pear price effect is partially accounted for by the supply of other canned fruits. Including both the pear price (*PB*) and the supply of competing fruits involves intercorrelation problems that make it difficult to separate their effects and does little to improve the accuracy of forecast. Therefore, *PB* was deleted.

The final price-markup equations are specified to have the form

$$PPR = A_{10}TCR^* \text{ and } PPF = A_{20}TCF^*$$

where TCR^* and TCF^* are as defined above and

$$A_{10} = a_{10}(IRR)^{a_{11}}(QCRN)^{a_{12}}(RSR)^{a_{13}}e^{u_3}$$
$$A_{20} = a_{20}(IRF)^{a_{21}}(QCFN)^{a_{22}}(RSF)^{a_{23}}e^{u_4}.$$

Substituting above and taking logs gives the form used for empirical estimation.

$$\text{(3)} \quad \ln PPR = b_{30} + b_{31}\ln TCR + b_{32}(D74)\ln TCR + b_{33}D74 + b_{34}T + b_{35}\ln IRR + b_{36}\ln QCRN + b_{37}\ln RSR + u_3$$

$$\text{(4)} \quad \ln PPF = b_{40} + b_{41}\ln TCF + b_{42}(D74)\ln TCF + b_{43}D74 + b_{44}T + b_{45}\ln IRF + b_{46}\ln QCFN + b_{47}\ln RSF + u_4.$$

In (3) and (4) ln *PPR,* ln *PPF,* ln *RSR,* and ln *RSF* are endogenous; *RSR* and *RSF* are ratios of supply to current movement. In logs, this adds two linear identities to the system:

$$\text{(5)} \quad \ln RSR = \ln\left(\frac{TSRN}{QMRN}\right) = \ln TSRN - \ln QMRN$$

$$\text{(6)} \quad \ln RSF = \ln\left(\frac{TSFN}{QMFN}\right) = \ln TSFN - \ln QMFN$$

where *TSRN, TSFN* are predetermined and *QMRN, QMFN* are current endogenous. The variables ln *RSR* and ln *RSF* relate closely to the quantities carried over to the next year, which as noted previously are jointly determined with price and movement.

We would expect the coefficients for total cost (b_{31} and b_{41}) to be positive. The coefficients b_{32} and b_{42} would be expected to be negative, reflecting the lower price-cost ratio with the increased cost level in 1974. The coefficients for *IRR* and *IRF* (the inventory ratios), *QCRN* and *QCFN* (per capita supplies of competing canned fruit), and *RSR* and *RSF* (per capita total supply divided by per capita sales) would all be expected to be negative. The coefficient for *D74* is likely to be positive, reflecting the general increase in level of price beginning in 1974 (possibly brought on by the psychological response to accelerated inflation rates and the new energy shortages). The coefficient for *T* ($T = 1$ in 1956), if significantly different than zero, is likely to be negative due to the declining ratio of price to cost.

The Total System

Equations (1) to (6) form a six-equation simultaneous equation system. Endogenous variables are ln *PPR,* ln *PPF,* ln *QMRN,* ln *QMFN,* ln *RSR,* and ln *RSF.* All others are exogenous or predetermined. Structurally, equations (1), (3), and (5) and (2), (4), and (6) could be viewed as separate simultaneous subsystems. However, the disturbance terms seem likely to be correlated among all equations. Hence they were estimated as a total system by the method of three-stage least squares.

Estimation Results

Estimates of the parameters of the demand and pricing system are presented in table 2. Ordinary least squares estimators are presented along with the three-stage least squares estimates for comparative purposes.

Referring first to the demand equations, the signs of all coefficients are consistent with expectations and are high relative to their standard errors. The values of the Durbin-Watson statistics are mildly suggestive of possible negative serial correlation of disturbances but are in the inconclusive range. The income variable reflects the effects of various time-related shifts including purchasing power (price level) changes.

The sign and significance of the variable *D70* support the hypothesis of the downward effect

Table 2. Estimates of FOB Processor Demand and Price-Markup Equations for Canned Peaches and Fruit Cocktail

OLS	R^2	d[a]	S[b]
1. $\ln QMRN = -.8963 - .6789 \ln PPR + .3947 \ln TDIN - .2169\, D70 + .0605\, T14 - .0048\, (T14)^2$ (.3528)[c] (.2196) (.1036) (.0811) (.0354) (.0017)	.803	2.58	.0724
2. $\ln QMFN = -.8782 - .9137 \ln PPF + .4310 \ln TDIN - .2682\, D70 + .0826\, T14 - .0053\, (T14)^2$ (.2505) (.1355) (.0594) (.0463) (.0181) (.0009)	.935	2.10	.0411
3. $\ln PPR = -.8015 + 1.3210 \ln TCR - .1640\, D74 \ln TCR - .0642 \ln IRR - .1384 \ln QCRN - .3254 \ln RSR + .2880\, D74 - .0150\, T$ (.1481) (.1121) (.0887) (.0164) (.0801) (.1289) (.1849) (.0025)	.997	1.75	.0267
4. $\ln PPF = -.1697 + .6422 \ln TCF - .0012\, D74 \ln TCF - .0596 \ln IRF - .5862 \ln QCFN + .1677 \ln RSF + .0594\, D74 - .0025\, T$ (.2125) (.1751) (.1180) (.0242) (.0867) (.1236) (.2365) (.0039)	.996	1.64	.0290
3SLS			
1. $\ln QMRN = -.8193 - .7286 \ln PPR + .3867 \ln TDIN - .2109\, D70 + .0666\, T14 - .0049\, (T14)^2$ (.3136) (.1952) (.0913) (.0714) (.0314) (.0015)		2.58	.0639
2. $\ln QMFN = -.8974 - .9036 \ln PPF + .4280 \ln TDIN - .2667\, D70 + .0818\, T14 - .0053\, (T14)^2$ (.2301) (.1244) (.0521) (.0402) (.0162) (.0008)		2.11	.0363
3. $\ln PPR = -.7364 + 1.3177 \ln TCR - .1179\, D74 \ln TCR - .6991 \ln IRR - .1034 \ln QCRN - .4446 \ln RSR + .1872\, D74 - .0147\, T$ (.1313) (.1007) (.0784) (.0142) (.0746) (.1392) (.1640) (.0022)		1.60	.0232
4. $\ln PPF = -.2254 + .7455 \ln TCR - .0382\, D74 \ln TCF - .0598 \ln IRF - .5250 \ln QCFN + .0267 \ln RSF + .1205\, D74 - .0046\, T$ (.1945) (.1704) (.1097) (.0212) (.0844) (.1422) (.2125) (.0037)		1.53	.0252

Note: See table 1 for variable definitions. Based on 1956–57 to 1982–83 observations.
[a] Durbin-Watson statistic.
[b] Standard error of the regression.
[c] Values in parentheses are standard errors.

Table 3. Comparison of Predicted and Actual Values for 1983 and 1984

	Logarithmic Variables					Actual Variables			
Equation	Dependent Variable	Actual Value	Predicted Value	Difference	S_F[a]	Dependent Variable	Actual Value	Predicted Value	Difference
				1983					
1	ln *QMRN*	4.1679	4.3017	−.1338	.0887	*QMRN*	64.58	73.83	−9.25
2	ln *QMFN*	3.6781	3.7208	−.0427	.0492	*QMFN*	39.57	41.30	−1.73
3	ln *PPR*	2.8112	2.7740	.0372	.0336	*PPR*	16.63	16.03	.61
4	ln *PPF*	2.9704	3.0352	−.0648	.0369	*PPF*	19.50	20.80	−1.30
				1984					
1	ln *QMRN*	4.1936	4.1823	.0091	.1061	*QMRN*	66.26	65.52	.74
2	ln *QMFN*	3.6313	3.6153	.0160	.057	*QMFN*	37.76	37.16	.60
3	ln *PPR*	2.9151	2.8431	.0720	.0415	*PPR*	18.45	17.17	1.28
4	ln *PPF*	3.0493	3.0804	−.0311	.0311	*PPF*	21.10	21.77	−.67

[a] Standard error of forecast for the structural equations. Values were computed by adding dummy indicators (0–1) for 1983 and 1984 and re-estimating as suggested by Salkever for single equation OLS. For a more general development of forecast errors for the restricted reduced form of simultaneous equation systems, see Pagan and Nichols.

on demand of the cyclamate ban in 1970. If all the effect of *D*70 is attributed to the cyclamate ban, it suggests that, with other factors constant, there was an initial market loss of about 21% for canned peaches and about 27% for fruit cocktail. However, the shift could reflect other factors as well. The quadratic trend then picks up the combined effects of an altered price structure under accelerated inflation, accompanied by a more general downward trend due to changing tastes and loss of export markets, possibly modified a bit by later recovery of some of the low-calorie or sugar-free market.

Because the demand functions are expressed in logs, the coefficients of *PPR* and *PPF* provide direct estimates of price elasticities at the FOB processor level (−.73 for canned peaches and −.90 for fruit cocktail).

The signs of the coefficients in the price-markup equations are also consistent with expectations and most are large relative to their standard errors. The values of the Durbin-Watson statistics suggest that serial correlation of disturbances is not a problem. The very high R^2 values for the OLS estimates of these equations are in part a reflection of the wide range of the price and cost variables (see appendix 1) and need not be taken too seriously.

The equations indicate that the FOB price has moved closely with the total cost of processing and raw product, with a downward shift in the derivative beginning in 1974. The lower coefficient for fruit cocktail likely is due to the fact the cost series includes only the raw product cost for peaches; but other fruits, especially pears, are also a component. The effect of changes in pear prices is reflected in the supply of competing fruit variable.

The level of carryover stocks relative to previous year supply (*IRR* and *IRF*) proved to be a highly significant price predictor for both canned peaches and fruit cocktail. The per capita supply of competing canned products (*QCRN* and *QCFN*) was a substantially more significant variable for fruit cocktail than for canned pears for the reasons noted previously—i.e., large supplies are associated with lower raw product prices for pears and hence lower costs. The endogenous variable *RSR* (total supply relative to current movement) proved to be highly significant for canned peaches, but *RSF* was not significantly different from zero for fruit cocktail. For peaches, the coefficient *RSR* indicates that the FOB price set by processors is a decreasing function of the total supply and an increasing function of current movement. The reason for the nonsignificance of *RSF* (total supply of fruit cocktail relative to current movement) is not clear. Apparently the carryover stocks, supply of competing products, and cost factors overwhelmed that variable. The overall negative trends seem likely because the reported processing cost series may not fully reflect the "true" cost of processing.

Evaluation

The empirical findings suggest that an econometric model based on the price-setter behavioral hypothesis can provide a good framework for estimating FOB processor demand and price relationships for two major canned fruits, peaches and fruit cocktail. Compared to an alternative price-taker model applied to the same data set (results not reported here), the price-setter model yields estimates that seem structurally more plausible and which have generally more desirable statistical properties. Hence, the modeling approach seems worthy of further exploration with other processed commodities where some degree of oligopoly seems evident.

The major limitation of this model (and all alternative specifications as well) is the necessity of accounting for some structural shifts by time-form variables. There are two points of concern: (*a*) the effect of the assumed time pattern of structural change on the estimates of other demand coefficients, and (*b*) the problem of extending time-form variables for forecasting purposes and otherwise anticipating future structural shifts.

With respect to the first concern, our interpretations of historical structural shifts in the demand for canned peaches and fruit cocktail seem reaonable, and the estimates of associated time coefficients are statistically significant. However, plausible alternative time-trend specifications would result in different estimators of slopes or elasticities, perhaps varying within a range of about ±20% of the values given in table 2.

Table 3 compares structural equation predictions with actual values for 1983 and 1984 where the trend variables [T, $T14$, $(T14)^2$] were simply extended forward along their time paths. These two years were not used in the statistical analysis. The predictions were obtained by inserting actual values in the right side of the structural equations. For more general forecasting purposes, of course, we would need to use the restricted reduced-form equations. However, the conditional predictions from the structural equations are more useful for present purposes because they are more revealing as to possible sources of error.[5]

Before turning to the comparisons it should be noted that in 1983 and 1984 FOB price data were no longer available from the same source (Kuznets) as the original data set. The Kuznets prices were calculated from industry-supplied data and were reported to reflect actual transaction prices. Our 1983 and 1984 observations are from private-label price quotations in the American Institute of Food Distribution reports, which are believed to be roughly comparable to the Kuznets series.

With that caveat it may be noted that all the conditional predictions, i.e., predictions taking all right-side variables in the structural equations as given, fall within two standard errors of forecast. Hence, no significant structural changes relative to the historical equations seem clearly evident.

While these results are encouraging, we have no basis for assuming that the time-related demand and pricing shifts will follow the same trajectory as in the past or even whether or not they will continue at all. Further, structural shifts such as appeared to occur in 1970 with the cyclamate ban or in 1974 with the onset of more rapid inflation may happen again. Hence, even though the estimates of model parameters are highly significant and even though the model explains a high proportion of the historical variation in the endogenous variables, especially prices, it is more suitable for conditional projections than it is for outright forecasting. Used in this more restricted context, the model may provide a useful beginning framework for industry analysis.

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[5] It is well known that predictions of original values from equations estimated with logarithmic dependent variables are biased. Kennedy suggests a correction for this bias but notes that the correction may worsen mean square error, providing a rationale for ignoring the adjustment. In view of other more serious concerns pertaining to projection of time-form variables, the predictions of original values were not adjusted for bias.

References

Brandt, J. A., and B. C. French. *An Analysis of Economic Relationships and Projected Adjustments in the U.S. Processing Tomato Industry.* Giannini Foundation Res. Rep. No. 331, University of California, Berkeley, Dec. 1981.

Droge, J. H., and R. H. Reed. *Prediction Analysis of United States and Wisconsin Wholesale Prices of Canned Cut Green Beans, Sweet Corn and Sweet Peas, 1948–1968.* Agr. Econ. Proj. Rep. (unnumbered), University of Wisconsin, 1973.

French, B. C., and M. Matsumoto. *An Analysis of Price and Supply Relationships in the U.S. Brussels Sprouts Industry.* Giannini Foundation Res. Rep. No. 308, University of California, Berkeley, March 1970.

Harp, H. H. *The Food Marketing Cost Index.* Washington DC: U.S. Department of Agriculture, Econ. Statist. and Coop. Serv. Tech. Bull. No. 1633, Aug. 1981.

Kennedy, P. "Logarithmic Dependent Variables and Prediction Bias." *Oxford Bull. Econ. and Statist.* 45(1983):389–92.

Kuznets, G. M. *Pacific Coast Canned Fruits F.O.B. Price Relationships 1980–81.* Giannini Foundation, University of California, Berkeley, Oct. 1981.

Minami, D. D., B. C. French, and G. A. King. *An Econometric Analysis of Market Control in the California Cling Peach Industry.* Giannini Foundation Monograph No. 39, University of California, Berkeley, Oct. 1979.

Pagan, A. R., and D. F. Nichols. "Estimating Predictions, Prediction Errors and Their Standard Deviations Using Constructed Variables." *J. Econometrics* 24(1984): 293–310.

The Food Institute Report. Fair Lawn NJ: American Institute of Food Distribution, weekly.

The Pacific Fruit News. Half Moon Bay CA, weekly.

Salkever, D. S. "The Use of Dummy Variables to Compute Predictions, Prediction Errors, and Confidence Intervals." *J. Econometrics* 4(1976):393–97.

Touche, Ross & Co. *Commodity Raw Product Pricing Application for the Marketing Cooperative,* Washington DC: U.S. Department of Agriculture, Agr. Coop. Serv. Processed. Not dated.

U.S. Department of Agriculture, Econ. Res. Serv., NED. *Working Data for Demand Analysis.* Washington DC, published annually.

Appendix 1
Data Used in the Analyses

Year	*PPR*	*PPF*	*TCR*	*TCF*	*IRR*	*IRF*	*QCRN*	*QCFN*
				Part A				
1956	5.35	6.22	5.22	5.18	.08	.14	.20	.26
1957	5.10	6.28	5.21	5.34	.20	.17	.20	.26
1958	5.36	6.83	5.31	5.54	.11	.17	.18	.22
1959	4.89	6.27	5.01	5.41	.15	.18	.21	.27
1960	4.86	6.17	4.91	5.25	.11	.15	.22	.27
1961	4.70	5.75	5.14	5.47	.14	.21	.23	.28
1962	4.50	5.40	5.04	5.30	.13	.20	.22	.28
1963	4.87	6.50	5.03	5.50	.11	.13	.18	.25
1964	4.51	5.78	4.98	5.36	.09	.14	.22	.30
1965	4.65	6.75	5.38	5.65	.16	.13	.20	.26
1966	4.63	6.00	5.35	5.71	.10	.20	.22	.29
1967	5.50	7.20	6.14	6.49	.12	.14	.17	.22
1968	5.30	6.35	5.88	6.29	.11	.18	.21	.27
1969	5.05	6.10	6.13	6.55	.17	.17	.22	.31
1970	5.60	7.30	6.61	7.15	.20	.16	.18	.26
1971	5.90	7.70	6.76	7.17	.21	.21	.19	.24
1972	6.50	8.20	6.87	7.35	.14	.26	.17	.21
1973	7.75	9.20	7.73	7.97	.06	.14	.16	.20
1974	9.90	11.15	10.56	10.71	.06	.08	.16	.23
1975	9.25	10.90	10.89	11.43	.14	.19	.18	.24
1976	9.60	11.35	11.16	11.92	.21	.19	.18	.23
1977	9.55	11.70	11.18	12.52	.18	.19	.16	.23
1978	11.15	13.90	12.48	14.12	.19	.16	.14	.19
1979	12.10	14.60	13.78	15.73	.13	.12	.15	.20
1980	13.00	15.95	15.46	17.85	.16	.17	.17	.22
1981	13.83	16.85	17.18	19.74	.23	.29	.15	.20
1982	14.40	17.50	17.55	20.32	.29	.32	.13	.18
1983	16.63	19.50	17.57	20.41	.22	.21	.12	.14
1984	18.45	21.10	18.45	21.23	.07	.17	.10	.14

Appendix 1
Continued

Year	*RSR*	*RSF*	*QMRN*	*QMFN*	*TDIN*	*TSRN*	*TSFN*
				Part B			
1956	1.25	1.21	108.80	62.01	.63	136.02	74.80
1957	1.12	1.21	120.15	61.69	.65	134.64	74.66
1958	1.18	1.22	97.58	61.17	.66	115.03	74.42
1959	1.12	1.18	122.96	68.52	.69	137.85	80.84
1960	1.17	1.26	115.01	65.89	.71	134.05	83.19
1961	1.15	1.25	125.21	72.89	.72	143.62	91.38
1962	1.12	1.15	138.08	80.04	.75	155.18	92.01
1963	1.10	1.16	135.88	67.12	.78	149.39	78.17
1964	1.19	1.15	145.95	82.73	.83	173.00	95.20
1965	1.11	1.26	131.71	69.22	.89	146.21	86.92
1966	1.14	1.16	147.77	84.16	.95	168.71	97.77
1967	1.13	1.21	118.87	66.59	1.00	134.22	80.86
1968	1.21	1.21	135.93	80.17	1.07	164.02	96.69
1969	1.29	1.26	142.02	78.61	1.14	183.10	98.68
1970	1.26	1.27	124.69	62.12	1.23	157.66	78.96
1971	1.16	1.35	118.98	59.95	1.31	137.71	80.82
1972	1.07	1.17	112.11	66.01	1.40	119.69	77.14
1973	1.06	1.09	102.97	68.33	1.57	109.51	74.18
1974	1.17	1.23	121.59	61.16	1.69	141.98	75.49
1975	1.26	1.24	110.16	62.51	1.84	139.13	77.51
1976	1.22	1.24	108.99	62.26	1.99	133.22	77.27
1977	1.23	1.19	121.27	62.00	2.17	149.18	73.81
1978	1.15	1.13	101.94	56.68	2.40	116.89	64.26
1979	1.19	1.21	101.81	56.89	2.66	121.65	68.87
1980	1.29	1.40	100.20	54.79	2.91	129.36	76.95
1981	1.40	1.47	85.12	48.69	3.23	118.79	71.50
1982	1.28	1.27	86.76	47.46	3.40	110.78	60.16
1983	1.08	1.20	64.58	39.57	3.62	69.39	47.68
1984	1.27	1.19	66.26	37.76	3.94	83.98	45.11

Note: See table 1 for variable definitions.

Appendix 2

Data Sources

The FOB prices, canned product movement, and stock data (*PPR, PPF, QMR, QMF, SP*) were obtained from Kuznets for 1956 to 1981. The price data are said to reflect actual transaction prices rather than list prices. After 1981, quantity and stock data were obtained from reports of the California League of Food Processors. FOB price data were obtained from reports of the American Institute of Food Distribution. They reflect private label prices and are believed to be comparable to the Kuznets series, but the exact degree of consistency is not known.

Data pertaining to the quantity of peaches canned or made into fruit cocktail (*QPR* and *QPF*) were obtained from annual reports of the California Canning Peach Association (CCPA). The processed product case yields per ton of farm product (*RP, RF*) were calculated from the pack data in Kuznets and the utilization data reported by the CCPA. The measures of unit processing cost (*PCR* and *PCF*) were calculated from data in a study prepared for the USDA Agricultural Cooperative Service by the accounting firm, Touche, Ross & Co. The cost estimates for the period 1978 and after were obtained by extending the Touche, Ross cost series using an index of processing cost, *PCI*. The *PCI* and the distribution cost index (*DCI*) were calculated from data and weights in Harp, extended for the years prior to 1967 from comparable series in the *Marketing and Transportation Situation* and ERS USDA Miscellaneous Publication 741 (computations available from the authors). Population (*N*) and disposable income (*TDI*) are official U.S. series (taken from ERS USDA *Working Data for Demand Analysis*). All quantity and price data are expressed on a crop-year basis beginning 1 June. Population was measured as of 1 July of the crop year, and *TDI* is for the calendar year in which the crop year begins. The period of analysis was 1956–57 to 1982–83.