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An Analysis of Economic Adjustments in the California-Arizona Lemon Industry

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AN ANALYSIS OF ECONOMIC ADJUSTMENTS IN THE CALIFORNIA-ARIZONA LEMON INDUSTRY

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SUMMARY AND HIGHLIGHTS

This report presents the results of an analysis of economic conditions and problems of the California-Arizona lemon industry. The industry has recently experienced a period of high production and low per acre returns, linked to a long-run cycle in lemon acreage and prices. The objectives of the study are:

- to assemble data on trends and conditions of supply and demand, including acreage, production, prices, costs, returns, and consumption patterns;
- to estimate demand conditions facing the industry for each major market outlet;
- to estimate short-run industry market allocation behavior;
- to estimate industry acreage response to changing economic conditions; and
- to simulate the economic impact of alternative fresh market allocations on lemon acreage, production, prices and real returns.

Because the lemon industry is subject to long-run production cycles, it is vulnerable to periods of boom and bust in which large acreage adjustments take place. These cycles are caused by the long lags that occur between changes in economic conditions and the associated changes in bearing acreage, and are influenced by factors both within and outside the industry. The two major expansions of the industry since 1950 have been associated with the growth of new market outlets. The development of new processed product forms in the 1950s encouraged the early growth of lemon production in Arizona and the California desert, but adversely affected demand for lemons in domestic fresh markets. As real returns declined in response to increased production, acreage began to decline in the early 1960s. New lemon plannings increased substantially in the late 1960s as investors exploited the tax shelter advantages of grove development. Although this activity was terminated by the Tax Reform Act of 1969, expanding export markets helped increase real returns to record levels, so that new plantings continued through the mid-1970s. The lag between planting and production sustained the growth in bearing acreage to a record high in 1981. This increased acreage, combined with a reduction in export opportunities, caused real returns to decline to a record low in the 1981-82 marketing year.

As total production increased and shifted more to the winter producing regions, changes also occurred in the utilization of the crop. Increased availability of processed products influenced a decline in per capita fresh utilization in the 1950s and early 1960s. As domestic fresh utilization leveled off in the late 1960s and 1970s, the increased production supplied the expanding export markets, with the excess diverted to processing. Thus, domestic fresh utilization declined in its share of total production from 55 percent in 1955-56 to 20 percent in 1980-81.

The principal causes of the lemon cycle are the long lags in the response of acreage to changing economic conditions. The estimated acreage response model indicates that lemon growers react to a number of factors in making planting and removal decisions. Removals, for example, were positively influenced by short-run decreases in real per acre revenues and by increases in price variability. New plantings were negatively influenced by the Tax Reform Act of 1969 which reduced the profitability of orchard development, and by longer run decreases in real per acre revenues.

Another factor possibly contributing to the cycle, but which was not measured, is the changes in the industry's farm structure between 1959 and 1974. From 1959 to 1969, the number of farms decreased and the average lemon acreage increased considerably in all three districts. From 1969 to 1974, however, acreage increased substantially, while the number of farms remained stable, indicating that the buildup of lemon acreage in that period came primarily from existing lemon growers.

The analysis of demand characteristics for California-Arizona lemons was carried out at the f.o.b. level in all three market outlets. Findings indicate that derived demand for fresh and export lemons is price inelastic, while that for processed lemons is elastic. The f.o.b. elasticity estimates were –.34 for domestic fresh lemons, –.96 for export lemons, and –2.11 for processed lemons, all measured at mean values.

A review of U.S. Department of Agriculture (USDA) household consumption survey data from 1965-66 and 1977-78 revealed a large reduction in household purchases of fresh lemons in domestic markets over this period, especially in the summer months. This decline, however, is not consistent with per capita consumption data which remain stable. It is possible that there was a major increase in the consumption of lemons away from home which would account for the discrepancy. If so, there are important implications for future marketing strategies.

By combining the long-run acreage response model with the short-run simultaneous demand and price prediction model, alternative fresh market allocation

scenarios were simulated over a 20-year period to compare their impacts on acreage, production, utilization, prices, and revenues. The alternative fresh market allocations varied from 2.1 to 2.4 pounds per capita, reflecting the range of values experienced by the industry from 1963 to 1982. The results of these simulations indicate that maintaining the fresh market allocation at 2.4 pounds per capita would have led to a steady decline in bearing acreage to about one-half of recent levels, leaving only very small quantities available for processing. More restrictive fresh market allocations, on the other hand, would have led to greater variability in acreage, production, and prices over the 20-year cycle. Real, per acre on-tree revenues are generally higher for the more restrictive allocations in the early years, and generally lower for these same allocations in the latter half of the cycle. It thus appears that less restrictive fresh market allocations can increase long-run industry stability, but at the cost of lower initial returns to growers.

Changes in consumer surplus and producer revenue in response to variations in the fresh market allocation were analyzed over the historic period, 1962-63 through 1983-84. In the short-term, an increase in fresh market allocation always resulted in a net increase in consumer surplus. After acreage adjusted over time in response to lower prices stemming from increased fresh market allocations, however, annual estimates showed decreases in consumer surplus. Over the total period, average consumer surplus increased as the fresh market allocation increased. Thus, we conclude that consumers would benefit from increased fresh market allocations of California-Arizona lemons. During the same period, f.o.b. producer revenues decreased as fresh market allocations increased with the average decrease in producer revenue exceeding the average increase in consumer surplus. Thus, gains in consumer surplus from increased fresh market allocations of lemons were more than offset by losses in producers' revenues for the historical simulations.

The simulation model was used to project future industry performance, given a set of assumed values for exogenous variables and a range of fresh market allocations. These projections indicate that recent decreases in bearing acreage of lemons can be expected to continue through 1991-92 with the level of bearing acreage related to the level of fresh market allocations. Working from a base fresh market allocation of 2.05 pounds per capita, estimated consumer surplus increased as the fresh market allocation was increased. Changes in average f.o.b. producer revenues for the 1984-85 through 1998-99 were positive for fresh market allocations of 2.1, 2.2, and 2.3 pounds per capita and negative for allocations of 2.4 and 2.5 pounds per capita. For the latter two allocations, the increase in consumer surplus was much greater than the decrease in producer revenue. Thus, there was a range of alternatives for which both consumers and producers benefited from increased fresh market allocations of lemons and a second range for which consumers benefited at the expense of producers. An examination of the annual pattern of gains and losses in consumer surplus and producer revenue indicates that the average values are sensitive to the length of the projection period. It is likely, for example, that adding a few years to the projection period would result in positive average annual changes in producer revenue for the 2.4 and 2.5 pound per capita alternatives.

1. INTRODUCTION

Lemons are an important citrus crop in California and Arizona where 1,974 farms have approximately 70,000 acres of lemon trees. These two states account for over 98 percent of total U.S. lemon production with Florida producing most of the remainder. California-Arizona lemon crop returns averaged over $134 million annually during the five years 1978-79 through 1982-83. California-Arizona lemon production is also an important component in the world lemon economy, as the U.S. share of world production ranged from 25 to 33 percent during the period 1970 through 1982.

Development of lemon groves involves a substantial and long-lasting commitment of resources. Land which is ideally suited for lemon production is limited in supply and expensive. There is a lag of four to six years from the time a tree is planted until it reaches bearing age and several more years are required to reach full commercial production. Average 1984 market prices for bearing lemon groves were $13,020 per acre in Southern California and $6,610 per acre in the San Joaquin Valley. The value of these groves responds quickly to factors affecting land prices as well as to the profitability of lemon production.

The California lemon industry has a long history of group action to solve marketing problems. In 1925, California lemon producers established a voluntary marketing agreement which restricted the volume of lemons sold on the fresh market in order to provide an acceptable level of prices. Under the leadership of the California Fruit Growers Exchange (now Sunkist Growers, Inc.) participation rates exceeded 90 percent of production during the first several years of operation. While the lemon industry enjoyed generally favorable prices for several years, increasing production, lower prices, and lack of full participation in the marketing agreement led to enactment of a federal marketing order in 1941. This marketing order, with amendments, continues in effect.

The principal provision of the California-Arizona Lemon Marketing Order, and one which has become increasingly controversial, is the weekly fresh market prorate. Under this provision, the Lemon Administrative Committee meets each week to determine the quantity of lemons to be shipped to the domestic fresh market. Each shipper is allocated a prorata share of the fresh market quota based on a moving average of lemons picked. Remaining fruit can be sold for export or processing. The prorate's primary function is to stabilize the intraseasonal flow of lemons to fresh domestic markets. In practice, this provision allows the industry to regulate the total annual volume sold in these markets. While stabilization of intraseasonal flows to domestic fresh markets stabilizes seasonal prices, observers question its long-run impact on production and prices.

The California-Arizona lemon industry faces several serious problems of both a short- and long-run nature. The industry is subject to acreage and production cycles due to the inherent lags between changes in the profitability of production and resulting supply adjustments. Acreage expanded rapidly from 1967 to 1975 with high levels of new planting, and the resulting growth in production depressed returns. Nominal on-tree total returns were lower during the 1982-83 crop year than at any time in the previous 20 years, despite increased population, higher consumer incomes, and a significant increase in the general price level. With increased acreage has come a greater diversity in interests among industry participants. The growth in acreage, which occurred entirely in the Central California and Desert districts, has increased seasonality of production. Fresh market consumption has remained relatively constant over the last decade, meaning that diversions to the processing market have increased. On-tree returns for lemons utilized by processing were negative for seven of nine years during the period 1974-75 to 1982-83.

While industry observers and participants generally agree that the lemon prorate increases total short-run revenue by restricting quantities sold in the more inelastic fresh market, many question its long-run impact. Since there is freedom of entry in lemon production, above equilibrium returns can be expected to encourage investment and an eventual increase in production. Opponents of the lemon marketing order charge that it unfairly increases prices paid by consumers for fresh lemons, that it has led to a chronic surplus of lemons and an inefficient allocation of resources, and that growers have not benefited from higher fresh prices because of the high proportion of fruit diverted to the lower priced processing market. The majority of growers and handlers support the order; they argue that it provides intraseasonal stability in the supply of fresh lemons to markets that are very vulnerable to gluts and shortages, that it allows small growers to compete with larger growers, and that it provides a measure of bargaining strength to handlers who face large buyers with significant market power.

The purpose of this report is to assemble economic data on the California-Arizona lemon industry, describe trends in acreage, production, and prices, and to construct an econometric model of the industry to use in assessing both short- and long-run impacts of alternative marketing policies under the marketing

order program. Note that we do not examine an industry scenario without the prorate provisions of the marketing order and, thus, we do not evaluate economic impacts of the lemon marketing order. Construction of the econometric model will require a detailed examination of the nature of demand and pricing relationships for lemons, the nature of acreage response and supply relationships in the industry, and the interrelationships between supply and demand. The econometric model will be used to simulate acreage, production, and price adjustments over time, given alternative allocations of lemons to the domestic fresh market. Industry revenues and consumer surplus at the f.o.b. level will be calculated for each simulation.

CALIFORNIA-ARIZONA LEMON PRODUCTION

Factors associated with the supply of lemons and production developments over time are examined in this section of the report. A model of lemon supply response will be specified and estimated.

LEMON ACREAGE TRENDS

There have been two major expansions of California-Arizona lemon acreage since 1950. As shown in Figure 1, each of these expansions has been followed by a significant contraction of both bearing and total acreage. The first expansion, which was associated with the development of the lemon processing industry, resulted in a total acreage peak of 70,597 acres in January 1958. Low farm level returns for lemons during the 1956-57 to 1961-62 crop years reduced new plantings, and nonbearing acreage decreased to a low of 1,837 acres in January 1964. The low point in total acreage was delayed until 1966 when acreage declined to 55,049 acres. Improved returns in the mid-1960s stimulated new plantings and total acreage began to increase again, reaching another high of 91,316 acres in January 1976. Note that nonbearing acreage reached an all time high of 23,967 acres in 1975. A decrease in real farm level returns for lemons beginning in 1974-75 led to reduced plantings, reduced nonbearing acreage, and a second major contraction of total acreage. Nonbearing acreage reached a low of 1,066 acres in 1981 as bearing acreage peaked at 76,794 acres. Bearing and total acreage decreased to 65,235 and 66,829 acres, respectively, in January 1985.

Acreage trends have demonstrated substantial differences among the three major California-Arizona lemon producing areas. The Southern California District (District 2) accounted for over 97 percent of the industry's total lemon acreage in the early 1950s. Total acreage in this district peaked at 63,316 acres in 1958 and then decreased rather steadily over time to a low of 34,007 acres in January 1984 (Appendix Table 1). This reduction has resulted in a concentration of District 2 acreage in Ventura County. With increased acreage in the other districts, District 2's share of total acreage decreased to less than 50 percent in 1984.

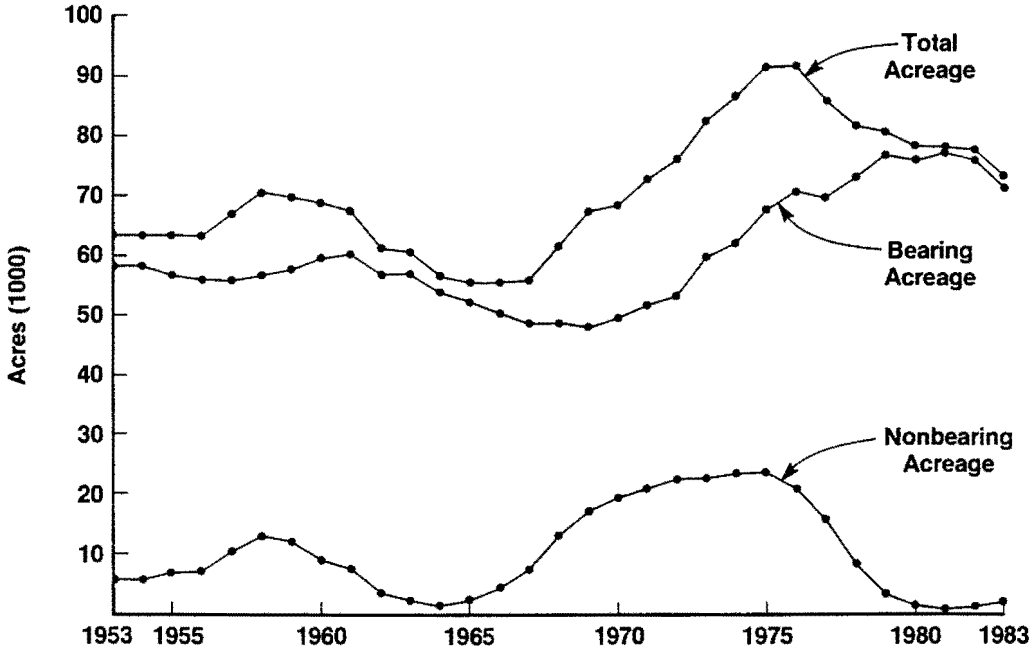
Central California (District 1) lemon acreage is concentrated in three southern San Joaquin Valley counties: Kern, Tulare, and Fresno. This district accounted for less than 2 percent of total lemon acreage in the early 1950s with just over 1,000 acres. Significant new plantings beginning in 1964 and continuing through 1974 resulted in total lemon acreage expanding to a high of 11,639 acres in 1975. District 1's share of total acreage was 14.4 percent in 1984.

The Arizona-California Desert (District 3) acreage is concentrated in Yuma County, Arizona. This district, which accounted for less than 1 percent of total acreage in 1950, experienced large new plantings in 1956-57 and again from 1964 to 1975. This expansion resulted in total acreage peaking at 34,387 acres in 1976. District 3 accounted for 36.9 percent of total California-Arizona lemon acreage in 1984 (Appendix Table 1).

LEMON PRODUCTION

Total California-Arizona lemon production is a function of bearing acreage and yield, each of which varies from year-to-year. As shown in Figure 1, the increases and declines in bearing acreage extended over a number of years. Most of the year-to-year variation in total production is due to annual changes in yields. While much of the variation in yields is due to differences in weather, two other factors are also important: the age distribution of the trees and changes in location of production. Note in Appendix Table 2 that average yields vary by district and that the pattern of variation is not uniform. While District 2 (Southern California) tends to have the highest average yields, it has also experienced the lowest yields on a few occasions. Average industry yields tend to be more stable than district yields. For the period 1955-56 through 1982-83 industry yields varied from a low of 456 cartons per acre to a high of 868 cartons per acre. During the same period the average low and high yields by district were: District 1,209 and 813 cartons per acre; District 2, 459 and 972 cartons per acre; and District 3, 153 and 939 cartons per acre. There has been a slight upward trend in average yields over time.

Figure 1. California-Arizona Lemon Acreage: Bearing, Nonbearing and Total, 1953-1983.



Source: Data in Appendix Table 1.

Economic factors appear to have had little impact on yields until recently because of the prorate system. That is, the "pick" system for allocation of prorate required that fruit be picked to qualify for fresh market prorate. Lemons were not abandoned for economic reasons. In fact, negative on-tree returns for lemons going to processing were common after 1974 (Appendix Table 11). With adoption of an on-tree certification program in the 1981-82 season, growers and handlers were able to qualify for fresh market prorate without being forced to harvest the fruit. Thus, yields can now be significantly affected by economic factors and one would not expect negative on-tree returns for processed lemons to persist. While the change to on-tree certification has not been in effect long enough to statistically measure its impact in this study, it could be an important factor in future studies.

As shown in Table 1, total California-Arizona lemon production has varied over the last two decades, roughly in line with trends in bearing acreage. Production during the last seven years, an annual average of 49,400 carloads, is the highest in the history of the industry. The total crop value has been increasing over time in current dollars but it has not increased in real terms.

Because of increases in costs of picking, packing, and transportation, there has been an increasing divergence over time between f.o.b. crop value and on-tree crop value. The on-tree total value of the lemon crop generally increased through the 1979-80 crop year and has decreased since. In fact, the on-tree nominal value of the 1982-83 crop at $30.94 million was lower than for any other lemon crop during the last 20 years. The situation is much worse when one accounts for inflation. The on-tree real value of the total 1982-83 crop, for example, was less than one-third of that existing for the smaller 1963-64 crop.

FARM STRUCTURE

The structure of fresh lemon production changed dramatically in the period 1959 through 1982. The most dramatic changes have been the declining number of farms and increased average farm size. By comparison, the increase in total acreage has been relatively modest. Table 2 presents data relating to the structure of production of fresh lemons in California and Arizona. Caution is required in interpreting these census data, however, because of definitional changes and differences in coverage between census years.

Both acreage and value of agricultural products sold were used to define a farm in the 1959, 1964, and 1969, agricultural censuses. The acreage criterion was dropped in the 1974 census when a farm was defined as an agricultural operation under individual management with normal sales of $1,000 or more in a year. This change of definition reduced the number of farms

Table 1. California-Arizona Lemon Production, Season Average f.o.b. Price and Total Crop Value, f.o.b. and On-Tree 1963-1983

Crop Year	Total Crop	Season Average Returns, Packing-House Door	Total Crop Value F.O.B.	On-Tree
	Carlot Equivalents	$/Carton	Million Dollars	
1963-64	37,037	1.34	49.63	33.39
1964-65	28,537	1.66	47.37	31.02
1965-66	32,110	1.64	52.66	35.41
1966-67	35,907	1.64	58.89	37.90
1967-68	34,053	1.92	65.38	46.53
1968-69	30,598	2.20	67.32	51.94
1969-70	30,304	2.43	73.64	49.35
1970-71	30,603	2.50	76.51	59.29
1971-72	34,975	2.40	83.94	63.62
1972-73	44,981	2.19	98.51	77.05
1973-74	35,554	3.08	109.51	75.32
1974-75	58,470	1.92	112.26	66.32
1975-76	35,052	2.90	101.65	49.85
1976-77	51,091	1.78	90.94	40.00
1977-78	52,027	2.12	110.30	68.40
1978-79	39,112	3.44	134.55	90.74
1979-80	41,466	4.06	168.35	119.03
1980-81	63,571	2.42	153.84	38.61
1981-82	50,058	2.13	106.62	37.75
1982-83	48,556	2.20	106.82	30.94

[a]The crop year is Nov.-Oct. through 1968-69 and Aug.-July, thereafter.

Source: U.S. Department of Agriculture, Agricultural Marketing Service. California-Arizona Lemons: Compilation of Statistics for Marketing Order Hearing, January 7, 1984.

Table 2. Structure of California-Arizona Fresh Lemon Production, 1959-1982

District[a]	1959			1964			1969		
	Number of Farms	Acres	Average	Number of Farms	Acres	Average	Number of Farms	Acres	Average
District 1 (CA)	1,524	2,117	1.39	640	1,994	3.12	286	5,095	17.81
District 2 (CA)	4,465	56,689	12.70	2,571	38,382	14.93	1,175	33,168	28.23
District 3 (CA and AZ)	739	3,808	17.08	539	3,526	17.72	453	15,458	34.12
Total	6,728	62,614	10.08	3,750	43,902	12.87	1,914	53,721	28.07
	1974			1978			1982		
	Number of Farms	Acres	Average	Number of Farms	Acres	Average	Number of Farms	Acres	Average
District 1 (CA)	238	8,648	36.34	290	9,022	31.44	246	7,399	30.08
District 2 (CA)	1,130	36,325	32.15	1,272	34,473	29.85	1,236	33,955	27.47
District 3 (CA and AZ)	430	26,928	62.62	517	30,782	59.54	492	28,660	58.25
Total	1,798	71,901	39.99	2,079	74,277[b]	37.92[b]	1,974	70,014[b]	35.47[b]

[a]See Appendix Table 4 for composition of districts.

[b]Acreage not reported for all farms. Average relates only to farms for which acreage reported.

Source: U.S. Department of Commerce, Bureau of the Census, Census of Agriculture, various issues.

counted in 1974. The 1978 and 1982 census continued the use of the 1974 definition. For the California counties which comprise the districts in Table 2, the total number of farms excluded by the change in definition is 3,994 or 9.7 percent of the total. If lemon farms were excluded in the same proportion, there would have been an increase in the number of farms between 1969 and 1974 rather than the decrease shown in Table 2.

Coverage of the 1978 Census of Agriculture was more complete than in any previous census. It was estimated that 9.5 percent of all farms in the western region were missed by the 1974 Census of Agriculture. Thus, the increase in number of farms between 1974 and 1978 would have been less than that shown in Table 2 if all farms had been counted in 1974. Data for 1978 and 1982 in Table 2 are more comparable because there was no change in definition or coverage.

Apparently the major decrease in farm numbers and increase in size took place between 1959 and 1969, a period over which there was very little change in definition or coverage. Keeping in mind these problems with census data, Table 2 indicates that average lemon acreage per farm increased from 10.08 to 35.5 acres between 1959 and 1982 and the number of farms fell by more than two-thirds.

LEMON SUPPLY RESPONSE

Modeling supply response for a perennial crop, such as lemons, involves incorporating extensive lagged adjustments not necessary when dealing with annual crops. The decision to develop a lemon grove is presumed to be based on expected returns over the life of the investment. Explaining the formation of expectations for many years into the future is difficult but previous empirical research indicates that the planting decision is often strongly related to recent price and production relationships. Once planted, lemon trees require from four to six years to begin producing and several more years to reach their full production potential. Production then occurs over an extended period, eventually decreasing as trees become old or diseased. Thus, lemon production is a function of lagged planting and removal decisions which together determine bearing and nonbearing acreage at any point in time. Annual production is the product of bearing acreage and average yield.

Previous Work

There are three studies which have specified and estimated models of acreage and production response for lemons. French and Bressler (1962) tested the hypothesis that the conditions for cobweb behavior were largely met in the California lemon industry. The model they estimated included behavioral equations for new plantings, tree removals, and lemon demand, and identities for bearing acreage and total production. Using this model, French and Bressler demonstrated a cyclical variation in acreage, production and prices. This study, based only on California data, was done before there were significiant plantings of lemons in Arizona. Carman (1981) used a supply response model to estimate the impact of tax law changes requiring capitalization of development costs for citrus and almonds on seven California orchard and vine crops. The model for California lemons included behavioral equations for plantings, changes in total acreage and average yields, and identities for bearing acreage and total production. Results of the analysis indicated that tax reform did have a significant negative impact on California lemon acreage and production. Application of the model to analysis of industry problems is limited as it did not include Arizona lemon acreage and production. Fox and Ribyat (1980) specified a three equation econometric model to use for medium-term projections of California-Arizona lemon acreage and production. They included behavioral equations for bearing acreage and average yield and an identity for total production. Since Arizona does not report plantings data, Fox and Ribyat were unable to estimate separate equations for plantings and removals.

The theoretical framework for models of perennial crop producer supply response has been developed and tested for several crops. Most recent empirical applications involve minor modifications and extensions of the basic model presented by French and Matthews.[1] The five major components of the French and Matthews model are: (1) functions for desired production and bearing acreage, (2) a relation between desired and actual planting, (3) an acreage removal equation, (4) relationships between unobservable expectations and observable variables, and (5) a yield equation.

A Model of Lemon Acreage Response

Bearing acreage of lemons changes over time as a result of plantings and removals. This relationship can be expressed as:

$$BA_t = BA_{t-1} + N_{t-k} - R_{t-1} \quad (1)$$

where BA is bearing acreage, the subscript t for time designates the year, k is a lag of k years required for a tree to reach bearing age, N is acres planted and R is

1. The French and Matthews model has been modified, extended and further validated for several perennial crops. Studies of supply response for perennial crops include: Rae and Carman (1975) for New Zealand apples; Baritelle and Price (1974) for Washington apples; Bushnell (1978) for almonds; Bushnell and King (1986) for almonds; Thor and Jesse (1981) for California-Arizona oranges; and Minami, French, and King (1979) for California cling peaches.

acres removed. Thus, explanation of changes in bearing acreage depends on explaining planting and removal behavior.

New Plantings. The acreage of new lemon trees planted during any year is based on the expected profitability of growing lemons over a life of approximately 30 years, the expected profitability of alternative crops, and other factors. Expected profitability is based on expected costs, expected returns, and expectations regarding variables which may affect costs or returns over time such as labor availability, technological change, tax law changes, price risk, development or loss of export markets, and urbanization. Note that there may be a delay between the decision to plant and actual planting because of land preparation, financing, and the availability of seedlings. Since expectations cannot be observed, estimation of a plantings equation requires specification of a set of observable variables related to expectations.

Producer expectations are typically assumed to be based on recent experience. Thus, empirical models of planting usually include lagged values for prices or total revenue adjusted for costs of production. Simple averages, geometrically weighted averages, and distributed lag formulations of various lengths have been employed. French and Bressler (1962) argued that lemon producers are well aware of the substantial year-to-year changes in supplies and prices and are, thus, likely to formulate their long-term expectations on the basis of average profits during several recent years. After testing periods of varying lengths, they utilized a five-year average of past net returns per acre as the proxy for expected profitability. Carman tried different lags and functional forms but also found that a five-year average of total revenue per acre divided by the index of prices paid by farmers yielded the best statistical results. Both of the above studies lagged the five-year moving average one year for the delay between the planting decision and actual planting. Fox and Ribyat (1980) did not estimate an equation for new plantings, but their equation for bearing acreage included a lagged three-year moving average of real total revenue per acre to account for the lagged impact of plantings on bearing acreage.

The affect of other factors on the planting decision have been difficult to isolate. French and Bressler were unable to specify a proxy variable for expected profitability for other crops because of the large number of other crops available. Their variable to measure acreage of old trees was not statistically significant and was deleted from the planting equation. Carman found that the 1969 Tax Reform Act did decrease plantings but no other factors were included in the planting equation.

In their total bearing acreage equation for lemons, Fox and Ribyat included a variable for real total revenue from oranges as a measure of expected profitability of other crops and an export variable to represent other factors affecting plantings. While these variables were statistically significant in the Fox and Ribyat specification, their results differ from other research estimating plantings equations for lemons or other citrus. In no other such study has other citrus or any major tree crop been isolated as a statistically significant alternative for the citrus crop in question. In addition, one would expect the impact of lemon exports on expectations to be reflected through price and profit variables rather than through a quantity variable.

Given the specification of variables in other studies, as well as trends and technical relationships in lemon production, we specified the following planting relationship:

$$N_t = f(TRLN_{t-1}, TAX, RISK) \quad (2)$$

where N_t is acres of lemon trees planted in year t, TRLN is a moving average of farm level total revenue per acre for lemons deflated by the producer's price index, TAX is a zero-one variable to measure the impact of cost capitalization provisions in the Tax Reform Act of 1969 and RISK is a measure of the variance of past prices.

Removals. Profit expectations are also important in the tree removal decision. Factors which may affect costs and returns include tree age, disease, urbanization, price risk and tax law changes. Except for the cling peach study by Minami, French and King (1979), empirical estimates of removal relationships for perennial crops have met with limited success due largely to data problems. French and Bressler (1962) were unable to relate removals to either profits or old trees; they estimated annual removals as a constant 4.5 percent of bearing acreage. The other studies for lemons have not attempted to directly estimate a removal relationship because of poor quality or lack of available data. Estimates of changes in total acreage and bearing acreage, however, do indicate that expected profits have an impact on removals.

Removals of lemon trees are affected by the age of trees, disease, price risk, and urbanization as well as by profit expectations. Because of data limitations, however, we specified a removal relationship based only on expected profits and price risk. The removals relationship is:

$$R_t = f(TRLR_{t-1}, RISK) \quad (3)$$

where R_t is acres of lemon trees removed in year t, TRLR is another moving average of farm level total revenue per acre for lemons deflated by the producer's price index, and RISK is a measure of variance of past prices.

Estimated Relationships. Data limitations preclude the direct estimation of planting and removal equations.[2] However, annual data on bearing acreage are collected by the Lemon Administrative Committee allowing us to indirectly account for the effect of plantings and removals by estimating an equation for annual changes in bearing acreage. Beginning with the bearing acreage relationship ($BA_t = BA_{t-1} + N_{t-k} - R_{t-1}$), the annual change in bearing acreage ($\Delta BA_t = BA_t - BA_{t-1}$) is:

$$\Delta BA_t = N_{t-k} - R_{t-1}. \quad (4)$$

The change in bearing acreage relationship is estimated by combining the planting and removal relationships into a single equation with appropriate lags for each of the variables. The time required to bring a lemon tree into bearing varies but an average of five years is typical. Previous work indicates that there is typically another year delay between the planting decision and actual planting. Thus, the change in bearing acreage relationship is:

$$\Delta BA_t = f(TRLN_{t-6}, TAX, TRLR_{t-1}, RISK_{t-6}, RISK_{t-1}). \quad (5)$$

This relationship was estimated as linear in all the variables using ordinary least squares. The variables TRLN and TRLR, which are moving averages of real total revenue per acre, serve as proxies for profit expectations as related to plantings and removals. The RISK variable is a moving average of the variance of prices which was included to measure the effect of risk and uncertainty on planting and removal decisions. Since there was no *a priori* expectation for a moving average of a particular length, various time periods were examined with the final selection based on statistical results. The TAX variable, which measures the impact of capitalization provisions in the Tax Reform Act of 1969 on lemon plantings, has a value of one for the years 1972-73 through 1975-76 and zero otherwise. This measures the lagged impact on bearing acreage of the large volume of publicly syndicated partnerships for tax sheltered investments in lemon grove development occurring from 1966-67 through 1969-1970. An alternative formulation which measures the negative impact of capitalization provisions on plantings has been utilized in other studies (see Carman, 1981). The downward shift in plantings indicated in this study, however, may not hold over time, given subsequent developments.

The estimated change in bearing acreage equation is:

$$\Delta BA_t = -6444 + \underset{(4.00)}{7.21}\, TRLN_{t-6} + \underset{(2.46)}{2510}\, TAX + \underset{(1.88)}{4.09}\, TRLR_{t-1} - \underset{(-2.62)}{9825}\, RISK_{t-1} \quad (6)$$

where $R^2 = .78$ and D.W. = 2.15. Values in parentheses are t ratios.

Equations utilizing moving averages of three, four, and five years for the variable TRLN were estimated; two, three, and four years, for TRLR; and two and three years, for RISK. The risk variable associated with the planting equation ($RISK_{t-6}$ in equation (5)) had very small and statistically insignificant coefficients in each of the estimated equations and was dropped from the analysis. The specification which provided the best statistical results, reported above in (6), has a four-year moving average for TRLN, a two-year moving average for TRLR, and a three-year moving average for RISK. Given the lag structure utilized, two of the variables, TRLN and TAX, are related to plantings and the other two, TRLR and RISK, are related to removals. Note that the change in bearing acreage variable (ΔBA) measures the change from January 1 of one year to January 1 of the following year and that prices and production are for an August through July crop year. Acreage data are matched with crop years, i.e., January 1, 1982, acreage corresponds to 1981-82 crop year prices and production.

Each of the estimated coefficients has the expected sign, is of a reasonable magnitude, and is statistically significant at the 5 percent level (one-tailed test). Increased real total revenue per acre is associated with increased plantings and decreased removals, each of which increases bearing acreage with the appropriate lag. Tax motivated development of lemon groves was adding an estimated annual average of 2,510 acres to plantings for the four years just prior to passage of the Tax Reform Act of 1969. The risk variable indicates that increased price variability is associated with increased removals and decreased bearing acreage. The Durbin-Watson statistic (D.W.) leads to acceptance of the null hypothesis of no serial correlation at the 1 percent level of significance.

Total lemon production during a crop year is the product of bearing acreage and average yield per acre. The simulation model developed in this study will utilize actual yields for simulations based on the historical period for which the supply-demand relationships were estimated. Average lemon yields for a given

2. Acreage data available for Arizona do not permit calculation of removals. California data also pose problems. Acreage estimates are from the California Crop and Livestock Reporting Service. Surveys are conducted in individual counties every three to six years; estimates are used for intervening years. Thus, one frequently faces the problem of calculated negative removals when deriving removals from published acreage estimates.

marketing year appear to be primarily influenced by weather, especially adverse weather. While production economics theory shows that the profit maximizing output (acreage times yield) of a commodity is dependent on product and input prices, there is limited opportunity in lemon production to adjust input usage to either product or input prices during a given year.[3] Thus, production response for lemons is based mainly on producers' decisions on acreage planted and removed rather than input usage. Fox and Ribyat's yield equation included independent variables for trend and adverse weather conditions; the variable for adverse weather added little expanatory power to their yield equation. Our interest is centered on yield trends related to changing cultural practices, changing location of production and technology since we use estimated yields only for projections. Thus, our projections will be based on an average trend in yields described by the regression equation:

$$Y = \underset{(77.25)}{6.06} + \underset{(4.32)}{.126KT} \qquad (7)$$

$$R^2 = .38 \quad D.W. = 2.65$$

where Y is the logarithm of average industry yield of lemons in cartons per acre and KT is the logarithm of time. The t-statistics in parentheses indicate that the coefficients are significant at the one percent level.

CALIFORNIA-ARIZONA LEMON UTILIZATION

Lemons grown in California and Arizona are utilized in both fresh and processed forms, including lemon oil, frozen lemonade, lemon juice, and canned lemon juice. Fresh market utilization includes both domestic and export allocations. Since April 1941, domestic fresh allocation has been regulated under Federal Marketing Order 910, as amended, which established the Lemon Administrative Committee to implement the order. The committee is composed of elected grower and handler members who have the authority to collect marketing information and recommend annual and weekly marketing policies for domestic fresh utilization. These policies, when approved by the Secretary of Agriculture, establish annual and weekly targets for quantities that can be shipped to domestic fresh markets. Lemons shipped to fresh export markets or processed into products are not subject to regulation by the order.

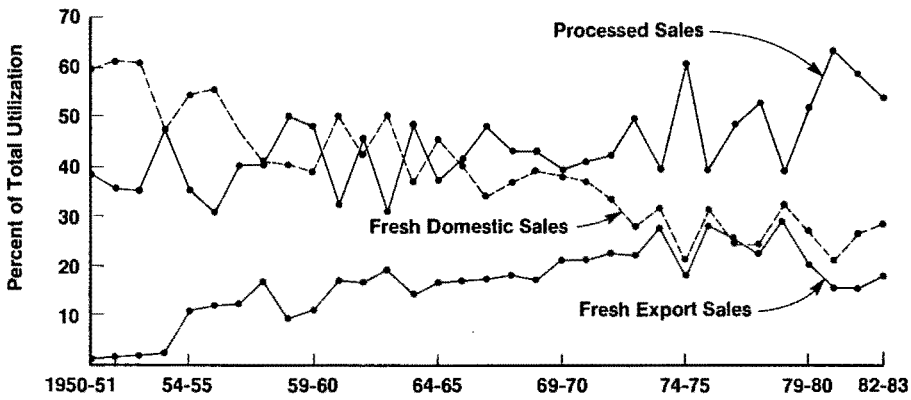
With the advent of new product forms in the 1950s, and the development of major export markets in the late 1960s and early 1970s, an increasing proportion of the total California-Arizona crop has been utilized in unregulated markets. Appendix Tables 5 and 6 show that total domestic fresh allocations have stayed fairly constant since the mid-1950s, while exports and processed utilizations have increased both totally and in their share of total industry production (see Figure 2). Processed lemon utilization shows the greatest fluctuation from year to year because of its role as the "residual" outlet. With total fresh movement showing only gradual changes over time, large fluctuations in yields and resulting crop size are reflected in highly variable quantities processed.

Appendix Tables 5 and 6 show total and percentage utilization by market outlet. Appendix Table 7 provides a breakdown of market utilizations by district, while Appendix Table 8 gives each district's proportionate allocation to each market. As noted above, the industry's total allocation to domestic fresh markets has remained relatively stable over the past 20 years, while export and processed movements have increased. These trends have been accompanied by a shift in the regions and season of production as acreages have increased in Districts 1 and 3 relative to District 2. Appendix Table 9 gives a breakdown of seasonal production by market outlet showing that fresh domestic and export movements have historically been higher in the summer than the winter, while products movement has been stronger in the winter since about 1959.

Effective August 1, 1971, Order 910 was amended to allow for revisions in the method of computing a handler's prorate base, and to provide for temporary loans and adjustments of prorate allotments. The first amendment established the so-called pick system through which a handler's prorate base is measured by the weekly average number of lemons picked. Total industry weekly average picks are then used as the available "supply," from which the designated weekly fresh marketing goal is shipped. Each handler's percentage of the total industry picks determines the weekly fresh allocation. The pick system eliminated the need to estimate the size of the "tree crop" for the industry and for each handler. Weekly averages are computed on the basis of variable-length periods depending on the harvesting patterns in each district.

3. This observation was confirmed by analysis of average lemon yields along the lines of the Houck and Gallagher (1978) treatment of price responsiveness for U.S. corn yields. There is not a dominant input for lemons, such as fertilizer is for corn—an input whose price varies up and down from year-to- year (see the orchard production cost index in Appendix Table 3).

Figure 2. Percentage Utilization of California-Arizona Lemon Production: Domestic Fresh, Export Fresh and Processed Sales, 1950-1983.



Source: Data in Appendix Table 10.

Because districts tend to forfeit allotments at the end of a season when they run out of fruit, while needing a greater base at the beginning of a season when harvesting rates are increasing, the amendments allow for accelerated averaging, upward adjustments, and loans and crediting of forfeited allotments. In addition, handlers can apply for a new prorate base after an eight week suspension of harvesting. These amendments were attempts to increase the flexibility of the system in allocating prorate, and to provide for equity of marketing opportunity at the beginning of each year.

At the end of each marketing year the committee uses field estimates of the size of the projected crop for the coming year and information on projected demand conditions to recommend a fiscal-year target for fresh domestic markets. Accompanying this annual goal is a projected schedule of weekly shipments which reflects seasonal peaks and troughs in domestic lemon demand. This schedule serves as a guideline to facilitate committee deliberations from week to week. At each regular weekly meeting, the committee adopts a weekly marketing policy based on reports of current levels of shipments, prices and picks; quantity and quality of lemons in storage; updated annual crop volume and quality estimates; projected two-month picks; and other factors affecting demand and supply. Size regulation recommendations are normally approved on a continuing basis until market conditions warrant a change.

Effective November 4, 1981, an emergency amendment was approved that permits handlers the option of including certified lemons left "on-tree" as part of their prorate base. Since growers no longer are forced to pick fruit to obtain fresh market prorate, this amendment reduces the need for handlers to divert excessively large volumes to processed products markets in order to claim their share of prorate. In recent years, such large diversions have resulted in negative "on-tree" prices, after picking, hauling, handling, and packing charges are deducted from f.o.b. prices.[4]

CHARACTERISTICS OF FRESH LEMON CONSUMERS

Data from USDA's 1965-66 and 1977-78 Food Consumption of Households in the United States surveys, are used to glean some information about fresh lemon consumption. Both surveys extended over a 12-month period and incorporated data collected from approximately 15,000 households (about 36,000 individuals).

Table 3 shows the proportion of sample households for all urbanizations who actually purchased fresh lemons in the survey week in both 1965-66 and 1977-78. Because of different samples in the two periods, comparisons between them can at best be regarded as some indication of the order of magnitude. The main conclusion to be drawn from Table 3 is that the proportion of households which purchased fresh lemons decreased substantially between 1965-66 and 1977-78. For the United States as a whole, only 9.2 percent of households purchased fresh lemons in 1977-78, compared with 16.1 percent in 1965-66. In 1965-66 the southern region had the highest proportion of

4. With the adoption of the on-tree certification program in 1981, large scale adjustments in annual supply as a result of low processing prices became possible. Estimates for use of the on-tree certification program since December 15, 1981, are: 1981-82, 9,308 carloads; 1982-83, 15,854 carloads; 1983-84, 11,543 carloads; and 1984-85, 2,415 carloads. Because of limited observations, this program was not included in the statistical model and thus, for the historical period, yield and production are assumed to be exogenous and predetermined at the beginning of a marketing year.

Table 3. Proportion of Sample Households Purchasing Fresh Lemons and Limes[a] by Area and Season in 1965-66 and in 1977-78

	United States		West		North Central		North East		South	
	1965-66	1977-78	1965-66	1977-78	1965-66	1977-78	1965-66	1977-78	1965-66	1977-78
	percent of households									
Year[b]	16.1	9.2	18.4	13.4	9.5	5.2	12.7	12.3	23.5	7.6
Spring	17.3	10.0	21.0	14.0	10.1	5.2	16.0	14.2	23.0	8.4
Summer	20.8	11.0	22.1	12.8	14.2	7.0	15.0	15.6	30.2	9.7
Fall	13.2	7.2	14.6	11.6	5.6	3.8	9.5	9.5	22.2	5.7
Winter	13.2	8.5	15.9	15.3	8.5	4.8	10.1	9.7	18.6	6.5

[a]Lemons and limes were not identified separately in the survey. It is assumed here that fresh lime purchases are so small that the results can be interpreted as relating primarily to fresh lemons.

[b]Derived as simple average of seasonal figures.

Source: U.S. Department of Agriculture, Human Nutrition Service, Food Consumption of Households in the United States, 1965-66 and 1977-78.

purchasing households, 23.5 percent. By 1977-78 the southern region had the second lowest proportion of purchasing households, 7.6 percent, the highest proportion being in the western and lowest in the northeastern regions. Fall is consistently the season in which the smallest number of households buy fresh lemons, while summer is generally the season for greater numbers of purchases. The exceptions to this were in the western region in 1977-78 when both winter and spring seasons had higher proportions of purchasing households than summer and in the northeastern region in 1965-66, when spring had a slightly higher proportion than summer.

Lemon consumption varies substantially by region and season, roughly in line with the proportion of households which purchase fresh lemons and limes. This variability is illustrated by data in Figure 3. Note that consumption per household was highest in the western region during each season and lowest in the northcentral area. Table 4 shows weekly purchases of fresh lemons and limes by area and season for the consumption surveys of 1965-66 and 1977-78. Data in Table 4 indicate that, for the United States as a whole, weekly purchases of fresh lemons and limes declined from 0.17 pounds per household in 1955-56 to 0.09 pounds per household in 1977-78.

Estimated 1977-78 expenditures on fresh lemons by households was extremely small, ranging from 2 cents per week in the northcentral region to 7 cents per week in the western region. These amounts constitute a negligible proportion of income and expenditure of all households. In an effort to determine what, if any, relationship exists between income and fresh lemon purchases, an Engel curve was estimated from the 1977-78 household food consumption survey. A graph showing the relationship between income and fresh lemon purchases in absolute terms is presented in Figure 4. There appears to be a positive, but not very consistent relationship between income and quantity purchased.

The estimated Engel curve, calculated from the cross sectional data used in Figure 4 is:

$$\underset{(-6.30)\ (2.50)}{LPUR = -3.959 + 0.169\ LIN} \qquad (8)$$

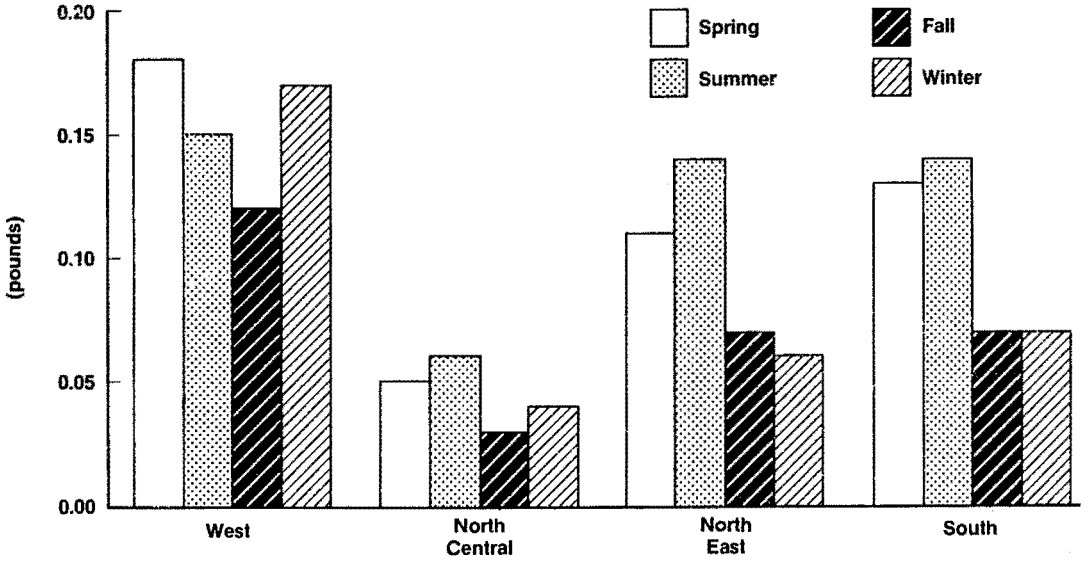
$R^2 = 0.33 \qquad N = 14$

where LPUR = log of the weekly quantity of fresh lemon purchases, LIN = log of annual income. Values in parentheses are t ratios.

An R^2 value of 0.33 is not unreasonable, given the cross-sectional nature of the data. N is the number of income categories used in estimating the equation. The lemon purchase data corresponding to these categories and the income data incorporated in them are derived from the total sample of about 15,000 households.

The estimated Engel curve indicates that a 10 percent increase in real income is associated with an increase of 1.69 percent in quantity of fresh lemons purchased. With a t-value of 2.50 the income coefficient is statistically significant at the 5 percent level. However, it is likely that the coefficient also reflects the effects of education, occupation and other factors which tend to be highly correlated with income. This coefficient relates specifically to household purchases of fresh lemons. Time series analysis of Hoos and Seltzer (1952), and Nicolatus (1977) also show a positive income effect, although of varying

Figure 3. Quantity of Fresh Lemons Consumed per Household per Week by Region and Season, All Urbanizations, 1977-78.



Source: USDA-Human Nutrition Information Service, Nationwide Food Consumption Survey, 1977-78.

Table 4. Weekly Purchases of Fresh Lemons and Limes by Area and Season, 1965-66 and 1977-78

	United States		West		North Central		North East		South	
	1965-66	1977-78	1965-66	1977-78	1965-66	1977-78	1965-66	1977-78	1965-66	1977-78
	pounds per household									
Year	0.17	0.09	0.18	0.15	0.09	0.04	0.12	0.09	0.26	0.10
Spring	0.18	0.11	0.20	0.18	0.10	0.05	0.14	0.11	0.26	0.13
Summer	0.26	0.12	0.26	0.15	0.18	0.06	0.16	0.14	0.40	0.14
Fall	0.12	0.07	0.13	0.12	0.03	0.03	0.10	0.07	0.20	0.07
Winter	0.11	0.08	0.12	0.17	0.05	0.04	0.07	0.06	0.19	0.07

Source: U.S. Department of Agriculture, Human Nutrition Service, Food Consumption of Households in the United States, 1965-66 and 1977-78.

Figure 4. Relationship Between Income and Fresh Lemon Purchases in 1977-78 (All Urbanizations, U.S.)

magnitudes and statistical significance. Coefficients derived from time series analysis may reflect different factors than those from cross-section analysis. It is likely that, in addition to education and occupation effects, the income elasticities derived from time series analyses also incorporate the effects of changing tastes and preferences and the effects of lemon promotion campaigns which may, in part, determine changes in tastes and preferences. In addition, the time series coefficients relate to total purchases of fresh lemons which include those by hotels, restaurants and institutions. The cross-sectional income variable only relates to households.

The decrease in fresh lemon purchases by households indicated by the household food consumption surveys is not totally consistent with aggregate per capita data. As shown in Figure 5, U.S. per capita consumption of fresh lemons decreased rather steadily from 3.4 pounds in 1955 to 2.2 pounds in 1967 and has remained in the range of 1.8 to 2.2 pounds since 1967. The apparent discrepancy between the decrease in household purchases of lemons from 1965-66 to 1977-78 and the rather stable per capita consumption figures after 1967 may be explained in part by general increase in food consumed away from home, a development which has affected consumption patterns for a number of agricultural commodities. While processed product consumption has been quite variable during the last decade, it has not increased to offset the decrease in fresh consumption. Note that the data reported in Figure 5 are based on quantities processed rather than actual disappearance in either domestic or export markets. Thus, imports, exports and other inventory adjustments would probably result in processed product consumption which was more stable than that indicated in Figure 5. In any event, there has been a general decrease in per capita fresh and total lemon consumption since the 1950s. As shown in the next section, changes in lemon consumption may be related to changes in lemon prices as well as changes in population, income and preferences. An empirical analysis of the demand for lemons at the f.o.b. level is a major focus of this study.

PRICE AND REVENUE TRENDS

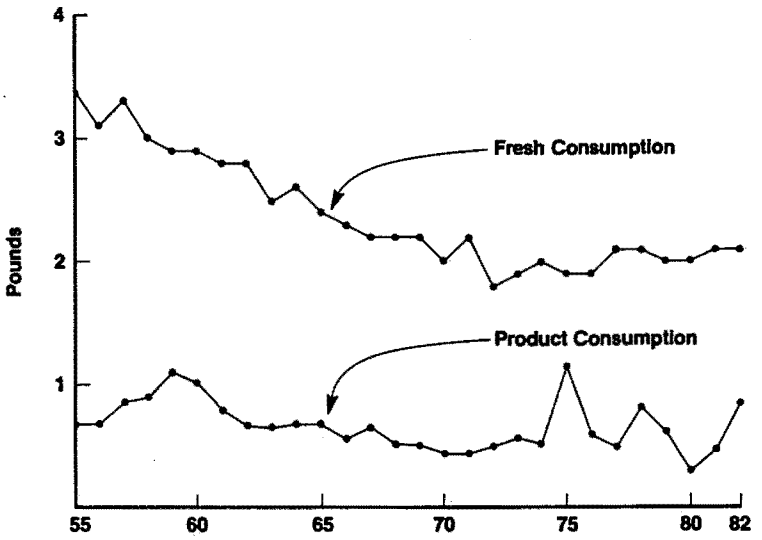
There are significant differences in f.o.b. lemon prices by use. As illustrated in Figure 6, average prices for lemons sold in fresh outlets are always higher than prices for lemons sold for processing. The economic basis for this wide and growing price differential is related to differences in price elasticity of demand among the different markets, the growth of export markets after 1964, and the use of the prorate provisions of the Lemon marketing order. Increased export opportunities in the late 1960s created upward pressure on prices in all three markets, with the greatest impact on the more inelastic fresh and export outlets. While the Lemon Administrative Committee (LAC) annual reports indicate a desire to maintain previous levels of shipments to the domestic fresh market, actual allocations steadily declined, further exacerbating the price differential. The inability of the industry to achieve LAC targets during this period may have played a key role in determining current industry acreage and production due to the lagged response of acreage to changes in per acre revenues.

Trends in acreage and production are associated with changing prices and revenues. Table 5 reports f.o.b. prices for fresh, export and processed lemons for the period 1950-51 to 1981-82 in both current and constant dollars. While these prices are averages over all districts and seasons, they do reflect market trends in the lemon industry over this period. For both domestic fresh and export markets, real prices declined in the late 1950s and early 1960s, began increasing steadily in the mid-1960s, peaked in the early 1970s and then declined, with the exception of 1977-78 and 1978-79 to their present levels. Prices for processed lemons generally followed the same trend, but at a lower level.

Net prices to lemon producers are always less than f.o.b. prices because of costs of picking, hauling, sorting, and packing. On-tree lemon prices by market expressed in both current and constant dollars are included in Appendix Table 11. While the pattern of price movements for f.o.b. and on-tree prices is similar, the difference between the two series increases over time. Note that the difference between the current dollar f.o.b. and on-tree fresh price was $1.33 per carton in 1950-51 and $3.99 per carton in 1981-82. The calculation of on-tree prices can result in negative prices if costs of picking, hauling, sorting, and packing exceed f.o.b. prices. Negative on-tree prices for lemons utilized for processing were reported for the years 1974-75 through 1977-78, 1980-81 and 1981-82.

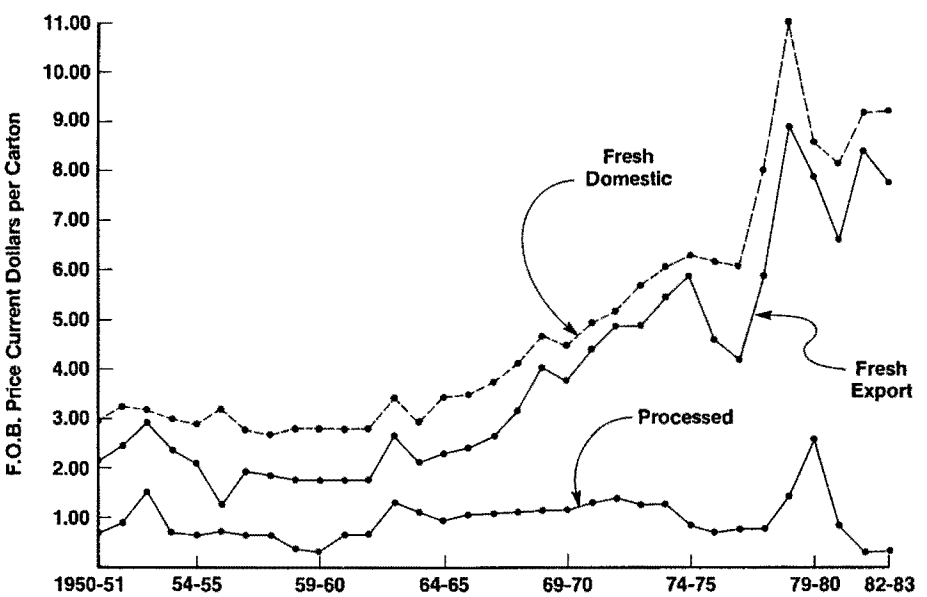
Grower returns for lemons are based on prices and quantities sold in each market (fresh, export, and processed) and average yields. Table 6 shows weighted-average prices per carton, total revenue, and per acre returns for the crop year 1950-51 through 1981-82, in current and constant dollars. While prices and per acre returns vary from year-to-year, cyclical movements are evident, especially in the constant dollar figures. Constant dollar (real) prices and per acre returns tended to decline through the 1950s and then increase through the 1960s, peaking in the late 1960s and early 1970s. For example, 1972-73 real per acre returns were $1,038.94. After 1972-73, real returns declined except for 1978-79, when crop yields were reduced by a freeze and returns averaged $863.07 per acre. In 1980-81 and 1981-82, real returns per acre decreased to $189.85 and $180.56 per acre, the lowest values in the postwar

Figure 5. United States Per Capita Consumption of Lemons and Lemon Products, 1955-1982.



Source: Data in Appendix Table 11.

Figure 6. California-Arizona Lemon Prices by Use, Dollars per Carton, F.O.B. Packing House, 1950-51 through 1982-83 Crop Years.



Source: Data in Appendix Table 7.

Table 5. California-Arizona f.o.b. Prices for Fresh, Export and Processed Lemons, 1950-51 through 1981-82

Year	Current Dollars			Constant Dollars[a]		
	Fresh	Export	Processed	Fresh	Export	Processed
	dollars per carton					
1950-51	2.95	2.11	0.64	3.61	2.58	0.78
1951-52	3.24	2.49	0.92	3.56	2.73	1.01
1952-53	3.17	2.93	1.53	3.58	3.31	1.72
1953-54	2.97	2.42	0.76	3.40	2.77	0.88
1954-55	1.88	1.10	0.64	3.29	2.40	0.73
1955-56	3.15	2.19	0.79	3.59	2.49	0.90
1956-57	2.73	1.93	0.64	3.01	2.13	0.71
1957-58	2.68	1.87	0.65	2.87	2.00	0.69
1958-59	2.84	1.78	0.46	3.00	1.88	0.49
1959-60	2.83	1.79	0.37	2.99	1.89	0.39
1960-61	2.81	1.82	0.64	2.96	1.92	0.67
1961-62	2.83	1.82	0.62	2.99	1.93	0.65
1962-63	3.43	2.72	1.40	3.62	2.87	1.47
1963-64	2.90	2.19	1.10	3.07	2.32	1.16
1964-65	3.45	1.39	0.97	3.64	2.52	1.02
1965-66	3.49	2.45	1.04	3.61	2.54	1.08
1966-67	3.64	2.61	1.02	3.65	2.62	1.02
1967-68	4.11	3.20	1.13	4.11	3.20	1.13
1968-69	4.66	4.03	1.11	4.55	3.93	1.08
1969-70	4.46	3.79	1.17	4.19	3.56	1.10
1970-71	4.95	4.44	1.32	4.48	4.02	1.20
1971-72	5.22	4.87	1.40	4.58	4.27	1.23
1972-73	5.71	4.88	1.30	4.80	4.10	1.08
1973-74	6.02	5.46	1.24	4.47	4.05	0.92
1974-75	6.26	4.84	0.86	3.91	3.65	0.54
1975-76	6.15	4.59	0.68	3.52	2.62	0.31
1976-77	6.04	4.24	0.74	3.30	2.32	0.49
1977-78	8.00	5.91	0.75	4.12	3.04	0.39
1978-79	10.91	8.92	1.48	5.21	4.26	0.71
1979-80	8.55	7.86	2.52	3.63	3.34	1.07
1980-81	8.11	6.57	0.87	3.02	2.44	0.32
1981-82	9.19	8.40	0.40	3.13	2.86	0.12

[a]The constant dollar prices are current dollar prices divided by the U.S. Department of Labor, Bureau of Labor Statistics, producer's price index for all commodities, 1967-69 = 1.00.

Source: Sunkist Growers, Inc., as presented in public testimony before USDA Lemon Marketing Order Administrative Hearings, 1984.

period. A comparison of the price and revenue trends in Table 6 with the acreage trends in Figure 1 reveals that peaks and troughs in real returns for lemons occur two to three years prior to the peaks and troughs in nonbearing acreage and, not coincidentally, about eight to nine years before the corresponding peaks or troughs in bearing acreage.

The wide swings in prices and per acre returns over the long run and their impact on plantings and removals of lemon groves have important implications with respect to the justification and operation of the marketing order for lemons. The descriptive information about price and revenue trends serves as a basis for a more rigorous economic analysis of f.o.b. demand relationships in the lemon industry. The next section describes the formulation and estimation of these demand relationships. These will be combined with the supply relationships, discussed and estimated previously, in a policy simulation.

LEMON DEMAND

At the handler (f.o.b.) level of the lemon marketing system, lemons are allocated to three separate market outlets. Fresh domestic sales, to both U.S. and Canadian fresh markets, are conducted under the regulation of the lemon marketing order, and therefore must adhere to size and volume requirements as approved by the Secretary of Agriculture. Fresh export marketing is not under marketing order regulation, but these markets tend to compete with domestic markets for high quality fruit. Processed products markets, which include concentrate and

Table 6. California-Arizona On-Tree Price Per Carton (All Use), Total Revenue and Per Acre Returns for Lemons, 1950-51 through 1981-82

	On-Tree Lemon Revenues					
	Current dollars			Constant dollars[a]		
Year	Per Carton All-Use Returns ($/carton)	Total Revenue ($ millions)	Per Acre Returns ($/acre)	Per Carton All-Use Returns ($/carton)	Total Revenues ($ millions)	Per Acre Returns ($/acre)
1950-51	1.02	27.53	472.74	1.25	33.68	577.92
1951-52	1.32	35.20	605.42	1.45	38.64	664.57
1952-53	1.53	38.93	665.99	1.73	43.94	751.68
1953-54	0.97	32.35	566.00	1.11	37.02	674.61
1954-55	0.96	27.07	478.47	1.10	30.90	546.20
1955-56	1.17	31.58	559.32	1.34	35.97	637.03
1956-57	0.76	23.90	416.70	0.84	26.35	459.43
1957-58	0.69	23.30	401.20	0.74	24.98	430.01
1958-59	0.60	21.47	357.89	0.64	22.69	378.31
1959-60	0.57	20.54	341.98	0.61	21.67	360.74
1960-61	0.82	22.87	398.25	0.86	24.10	419.65
1961-62	0.70	22.66	393.48	0.78	23.98	416.38
1962-63	1.52	40.60	739.85	1.60	42.82	780.43
1963-64	0.90	33.39	627.26	0.95	35.33	663.77
1964-65	1.09	31.02	613.70	1.15	32.75	648.04
1965-66	1.10	35.41	730.51	1.14	36.66	756.22
1966-67	1.05	37.90	780.90	1.05	37.98	782.47
1967-68	1.38	46.53	971.42	1.38	46.53	971.42
1968-69	1.70	51.94	1058.45	1.66	50.67	1031.63
1969-70	1.59	49.35	950.94	1.49	46.34	892.90
1970-71	1.84	59.29	1116.17	1.66	53.70	1011.03
1971-72	1.80	63.62	1069.00	1.58	55.80	937.72
1972-73	1.76	77.05	1236.34	1.47	67.75	1038.94
1973-74	2.03	75.32	1122.14	1.50	55.91	833.07
1974-75	1.19	66.32	940.78	0.75	41.42	587.62
1975-76	1.29	49.85	714.87	0.74	28.50	408.73
1976-77	0.80	40.00	545.99	0.53	21.86	298.35
1977-78	1.31	68.40	895.02	0.67	35.22	460.88
1978-79	3.86	137.17	1806.41	1.85	65.54	863.07
1979-80	2.63	119.03	1550.02	1.12	50.52	657.90
1980-81	0.61	38.61	510.33	0.23	14.36	189.86
1981-82	0.86	37.75	529.77	0.30	12.87	180.56

[a]The constant dollar prices and returns are the current dollar figures divided by the U.S. Department of Labor, Bureau of Labor Statistics, producer's price index for all commodities, 1967-68 = 100.

Source: Sunkist Growers, Inc., as presented in public testimony before USDA Lemon Marketing Order Administration Hearings, 1984.

single strength juice, frozen lemonade, and lemon oil, typically take the lowest quality fruit available, as measured by fresh market standards. The very low returns that these latter markets have shown in times of excess supply result from the allocation of surplus fruit after domestic and export allocations are made.

From a theoretical perspective, modeling the demand and allocation of lemons to these three markets presents several difficulties. In previous studies of lemon demand, allocations were treated as predetermined because domestic allocation was targeted before the marketing year started, exports were small and products allocations were simply the residual of the available crop for that year (see, e.g., French and Bressler, 1962; Hoos, 1956; Hoos and Kuanets, 1962). Demand was thus modeled in single-equation form with prices dependent on the quantities allocated to both domestic outlets, so that fresh and processed lemons were viewed as substitute or competing commodities which were predetermined variables.

With the increased importance of exports in recent years, however, three problems with this approach have emerged. The first is the problem of estimating export demand, either in aggregate form or by separate regional markets. In either case, measures of exogenous shift variables and changes in relative currency values are needed to specify demand for fresh lemons in foreign markets. In addition, structural changes due to changing tariffs and trade barriers complicate the modeling task. The second problem involves the simultaneous determination of export and processed allocation and prices in all three markets. If export allocation decisions are determined at least in part by current prices, and prices are in turn determined by quantities allocated, the single-equation specification would not be appropriate due to simultaneous equation bias. The third problem is that the interaction of economic behavior across these three markets suggests that the errors across equations may be correlated.

To address the many specification problems of lemon demand, a two-step procedure was followed. Initial alternatives concerning functional forms, choice of variables, and form of variables used were screened by estimating a large number of single-equation combinations using ordinary least squares. While these estimates do not provide theoretically or statistically defensible results, they did provide indications of appropriate variable combinations and linkages within the system. The results of this screening procedure thus provided guidelines for the specification of the simultaneous system which was estimated using a full information maximum likelihood (FIML) procedure. This FIML model was then combined with the long-run acreage response model to simulate alternative marketing policies over both historical and future time periods.

Specification of the simultaneous allocation and demand system is based on several operational characteristics of the industry and the federal marketing order. Fresh domestic allocations are still assumed to be predetermined, following previous modeling efforts. While there appears to be some deviation of these allocations from preseason targets, the differences were usually small. This assumption implies that the fresh domestic price is dependent on fresh allocation, competing product allocations, and exogenous shift variables. The resulting specification is:

$$PF = f(QF, QP, Y, POP)$$

where PF = fresh domestic price,
QF = fresh domestic allocations,
QP = domestic product allocations,
Y = disposable personal income in current dollars, and
POP = U.S. and Canadian population.

The key question in modeling export markets is specifying the linkage between fresh domestic and export prices. As indicated by Table 5 and Figure 6, domestic fresh and export prices have moved together very closely over time. In talking with lemon handlers about how export prices and quantities are determined, it appears that export prices are based on domestic fresh prices, and quantities demanded then adjust accordingly. Thus, the export price equation reduces to a simple linear function of domestic fresh price,

$$PE = f(PF).$$

This price linkage then implies that export demand is based on price:

$$QE = f(PEXR, NDSPOP, NICGDP, T)$$

where QE = quantity exported,
PEXR = exchange rate adjusted export price,
NDSPOP = population of western industrial countries,
NICGDP = aggregate nominal industrial country gross domestic product, and
T = time trend.

The time trend is entered to reflect the structural adjustments in the growth of export markets in the trans-Pacific market.

Because processed allocation is the residual of fresh domestic and export allocations, processed price is dependent on these allocations. In addition, the existence of processed products inventories mean that these allocations can show lagged impacts over several years. Due to the lack of data on inventories, a two-year moving average of past product allocations was

used as a proxy. A linear time trend represents the shift in consumption of frozen and convenience foods over time. Finally, two years of heavy frost damage were modeled using dummy shifters in those years to reflect price responses at very low levels of supply. The resulting processed market specification is,

PP = f(F53, F79, QP, A2QP, T)

where PP = processed price,
F53,F79 = freeze year dummy variables, set = 1 in 1953 and 1979, respectively; = 0, otherwise.
QP = quantity processed,
A2QP = two-year moving average of quantity processed, and
T = time trend.

Estimation of the Simultaneous Market Demand and Allocation Model

Due to the hypothesized simultaneity between fresh domestic, export, and processed markets, a simultaneous demand and allocation system was specified and estimated by FIML. The simultaneous model specification is summarized in Figure 7. Besides the four equations already introduced are two identities: the exchange rate adjusted export price and an allocation relationship which specifies that the total annual supply of lemons is equal to the sum of processed, domestic fresh and export quantities. Thus, there are six equations and six endogenous variables in the simultaneous block: processed price, fresh price, export price, adjusted export price, export quantity and processed quantity. The quantity fresh and total quantity are considered to be predetermined since the marketing order determines the amount of lemons allocated to the domestic fresh market and total quantity of lemons is determined by the product of bearing acreage and yield, as noted above. Each equation is overidentified.

The results of the FIML estimation are presented in Table 7. In the fresh price equation, fresh domestic allocation and disposable income are statistically significant variables, while processed allocation and population are not. Fresh domestic price is a highly significant predictor of export price. All included variables were significantly different from zero in the export demand equation. In the processed price equation, both processed allocation variables and time are significant. While several of the included variables are not significant in the FIML estimation their inclusion in the specification was based on theoretical considerations as well as their impact on both the statistical portion of the model and its performance in historical simulations.

Price flexibilities of demand can be calculated from the estimated fresh and processed price equations and the inverse of these flexibilities can be used as approximations of the price elasticities of demand measured at the f.o.b. level.[5] Using this procedure, the estimated price elasticity of demand for fresh lemons at

Figure 7

SIMULTANEOUS DEMAND AND ALLOCATION MODEL

Fresh Market Equation:
PF = f(QF, QP, Y, POP)

Fresh-Export Price Linkage Equation:
PE = f(PF)

Exchange Rate Identity:
PEXR = PE*EXRT

Export Demand Equation:
QE = f(PEXR, NDSPOP, NICGDP)

Allocation Identity:
QP = QT - QF - QE

Processed Market Equation:
PP = f(F53, F79, QP, A2QP, T)

PF	= average annual fresh domestic lemon price f.o.b.,
QF	= annual fresh domestic lemon allocation,
QP	= annual processed lemon allocation,
Y	= disposable personal income,
POP	= annual U.S. and Canadian population,
PE	= average annual fresh export price f.o.b.,
PEXR	= exchange rate adjusted export price,
EXRT	= trade-weighted rate of exchange of U.S. dollars to a basket of industrial country currencies,
NDSPOP	= western industral country population,
NICGDP	= nominal industrial country aggregate gross domestic product,
QE	= annual fresh export market allocation,
PP	= average annual processed market price f.o.b.,
F53,F79	= freeze year dummy variables,
A2QP	= 2-year moving average annual processed allocations,
T	= linear time trend.

5. The reciprocal of the direct price flexibility forms the lower bound, in absolute terms, of the direct price elasticity. The weaker the effects of substitution and complementarity, the better the approximation. Meinken, Rojko, and King (1956) present the algebraic relationships between the reduced form (price dependent) coefficients and the coefficients for the structural demand equations. For a discussion of the relationships between price flexibilities and elasticities of demand, see Houck (1965) and/or Chavas, Hassan, and Johnson (1981).

Table 7. Estimated Simultaneous Equations Simulation Model[a]

Variables	Equation			
	Processed Price	Fresh Price	Export Quantity	Price Linkage (export to fresh)
	Coefficients and Asymptotic t-ratios			
Constant	1.323 (9.598)	32.811 (1.971)	418.216 (4.827)	-0.515 (-1.092)
'53 Freeze Dummy[b]	.752 (.020)			
'79 Freeze Dummy[c]	1.411 (.027)			
QF(million cartons)		-1.041 (-2.044)		
QP(million cartons)	-0.0275 (-2.702)	-0.034 (-1.038)		
A2QP(million cartons)[d]	-0.0548 (-5.00)			
YMM($1,000 billion)[e]		6.136 (3.639)		
POP(million persons)[f]		-0.0853 (-1.678)		
PEXR(dollars per carton)			-1.570 (-4.342)	
NDSPOP(billion persons)[g]			-0.496 (-4.790)	
NICGDP ($1000 billion)[h]			-3.442 (-3.139)	
T	0.0529 (4.447)		6.281 (4.977)	
PF				0.911 (12.383)

[a]The full information maximum likelihood technique was used to obtain parameter estimates.

[b]A dummy variable to capture the effect of the 1953 freeze. It equals 1 for 1953; 0 otherwise.

[c]A dummy variable to capture the effect of the 1979 freeze. It equals 1 for 1979; 0 otherwise.

[d]Two-year lagged moving average of quantity processed.

[e]U.S. disposable personal income (current value); Source: U.S. Department of Agriculture, Working Data for Demand Analysis.

[f]Annual estimate of the combined population of the U.S. and Canada; Sources: U.S. Department of Agriculture, Working Data for Demand Analysis; Statistics Canada; International Monetary Fund.

[g]Population of industrialized nations; Source: International Monetary Fund; U.S. Department of Commerce, World Population.

[h]Nominal aggregate industrial country GDP; Source: International Monetary Fund.

the mean values of f.o.b. price and quantity is -.34. The most elastic estimate within the range of observed values is -.85. The estimated price elasticity of demand for processed lemons measured at the mean values of price and quantity is -2.11. These estimates are consistent with work done for much earlier time periods, including research by Hoos and Seltzer (1952). The estimated price elasticity of demand for export lemons, measured at mean values, was -.96.

Simulation of Lemon Industry Behavior

The combined relationships for lemon production, prices and changes in bearing acreage comprise a block recursive system. The specification of these relationships is based on the recursive nature of the industry model. Total lemon production for a given year (t), which is the product of bearing acreage and average yield, is predetermined. The allocation of this total production to fresh domestic and processed outlets together with exogenous demand shifters determines prices in each outlet. Fresh export price is determined by fresh domestic price while export demand is determined by export price and demand shifters. The weighted average f.o.b. price less packing, storage, transportation and picking charges yields the farm level average price. Total revenue per acre (price times average yield) deflated by an index for changes in costs of production serves as a proxy for profit expectations. Lagged moving averages of real total revenue per acre and exogenous shifters determine net changes in bearing acreage (lagged plantings and current removals) for the next year (t+l). The new bearing acreage in year t+l is, thus, a function of past production, market allocation and prices.

The estimated change-in-bearing-acreage relationship is combined with the simultaneous equation model of lemon demand, allocation, and prices to simulate the behavior of bearing acreage, production, and prices of California-Arizona lemons. Because the acreage response equation involves 11-year lags, actual prices, market allocations, and yields are used for the first 12 years to start the model operating. These lead to a predicted net change in bearing acreage and the resulting total bearing acreage in year 13. Actual yield combined with estimated bearing acreage results in estimated total production for the crop year. For the base simulation, actual allocations to the fresh market in that year, combined with actual values for exogenous variables, are used to predict the values of the endogenous variables, which include export and processed allocations, prices, and revenues. Predicted prices and movements are used to calculate an overall estimated f.o.b. price. The estimated f.o.b. price minus the actual marketing charge results in the farm level price. The estimated price and actual yield generates a real gross revenue per acre, which enters the moving average of real revenue per acre to calculate an estimated change in bearing acreage and a new bearing acreage for year 14. The above sequence of calculations is then performed for each subsequent year in turn, with solved values of endogenous variables used to generate succeeding values. The estimates representing the historical or base simulation are shown in Table 8 for the period 1962-63 through 1982-83, together with actual values for bearing acreage, average f.o.b. price and total per acre revenue for California-Arizona lemons.

Examination of Table 8 indicates that the simulation model closely approximates bearing acreage, average f.o.b. prices and total revenue during the period 1962-63 through 1982-83. Figures 8, 9, and 10 show plots of actual and simulated bearing acreage, f.o.b. price, and real per acre revenue for this period.

Statistics for bearing acreage and prices show the close correlation between the actual and simulated series. The statistical correlation between actual and simulated bearing acreage is .9934, the root-mean-squared error is 1348 and the mean absolute error is 1179. The correlation between actual and simulated f.o.b. prices is .9519, the root-mean-squared error is 0.3301 and the mean absolute error is 0.2591.

Table 8. A Comparison of Simulation Model Results With Actual Bearing Acreage, f.o.b. Prices and Total Revenue, 1962-63 through 1983-84

Marketing Season	Bearing Acreage		Average F.O.B. Price		Total Revenue	
	Actual	Simulated	Actual	Simulated	Actual	Simulated
	------acres------		-dollars per carton-		million dollars, F.O.B.	
1962-63	57,592	55,893	2.67	2.54	71.32	65.80
63-64	54,872	53,782	1.92	1.75	71.35	63.69
64-65	53,225	51,579	2.34	2.60	66.69	71.77
65-66	50,538	49,458	2.28	2.35	73.65	74.26
66-67	48,484	47,748	2.20	2.45	79.25	85.78
67-68	48,535	47,006	2.63	2.68	88.70	87.33
68-69	47,902	47,200	3.01	3.22	92.08	97.03
69-70	49,067	48,487	3.00	3.38	93.44	103.82
1970-71	51,893	51,206	3.34	3.54	107.84	112.73
71-72	53,119	55,347	3.51	3.31	123.77	121.77
72-73	59,509	58,895	3.32	3.00	145.83	130.27
73-74	62,322	61,069	3.96	3.80	146.87	138.15
74-75	67,117	65,628	2.92	2.75	162.32	149.63
75-76	70,495	69,585	3.52	4.00	136.29	152.84
76-77	69,733	72,241	3.01	2.98	151.19	155.17
77-78	73,258	74,840	3.72	3.32	194.75	177.94
78-79	76,423	75,065	6.71	5.68	238.34	198.19
79-80	75,937	75,644	5.26	5.48	238.48	247.28
1980-81	76,794	76,393	3.26	3.42	206.19	215.62
81-82	76,655	75,573	3.90	4.25	193.19	207.50
82-83	71,263	73,096	4.40	4.55	223.08	219.31
83-84	67,818	70,232	5.91	5.85	244.95	251.56

FIGURE 8. COMPARISON OF ACTUAL AND SIMULATED BEARING ACREAGE FOR CALIFORNIA-ARIZONA LEMONS, 1962-63 TO 1982-83.

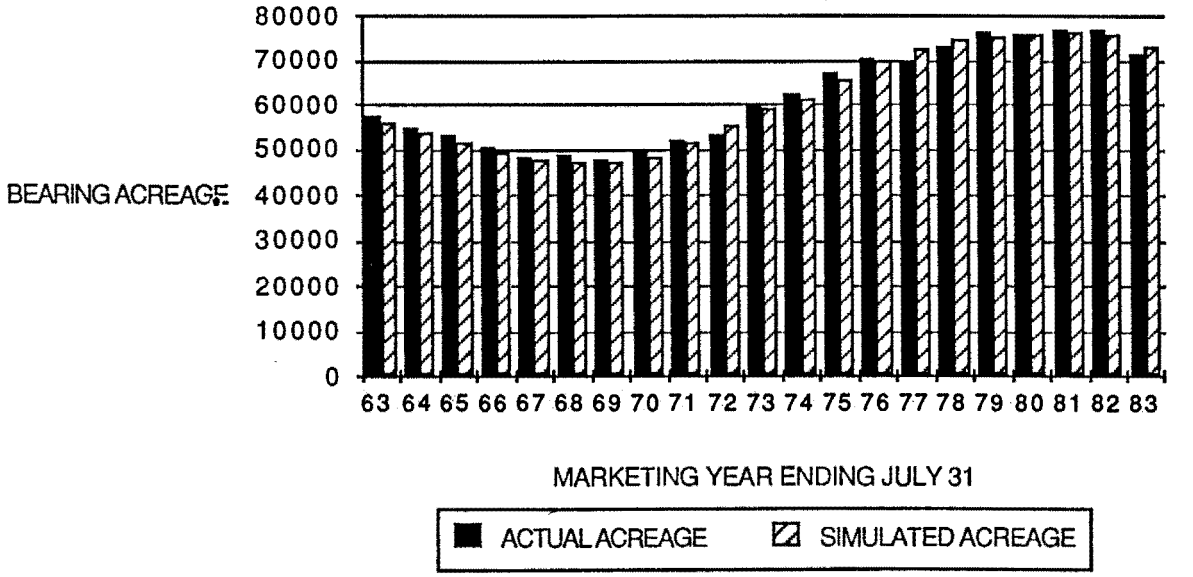


FIGURE 9. COMPARISON OF ACTUAL AND SIMULATED F.O.B. PRICES FOR CALIFORNIA-ARIZONA LEMONS, 1962-63 TO 1982-83

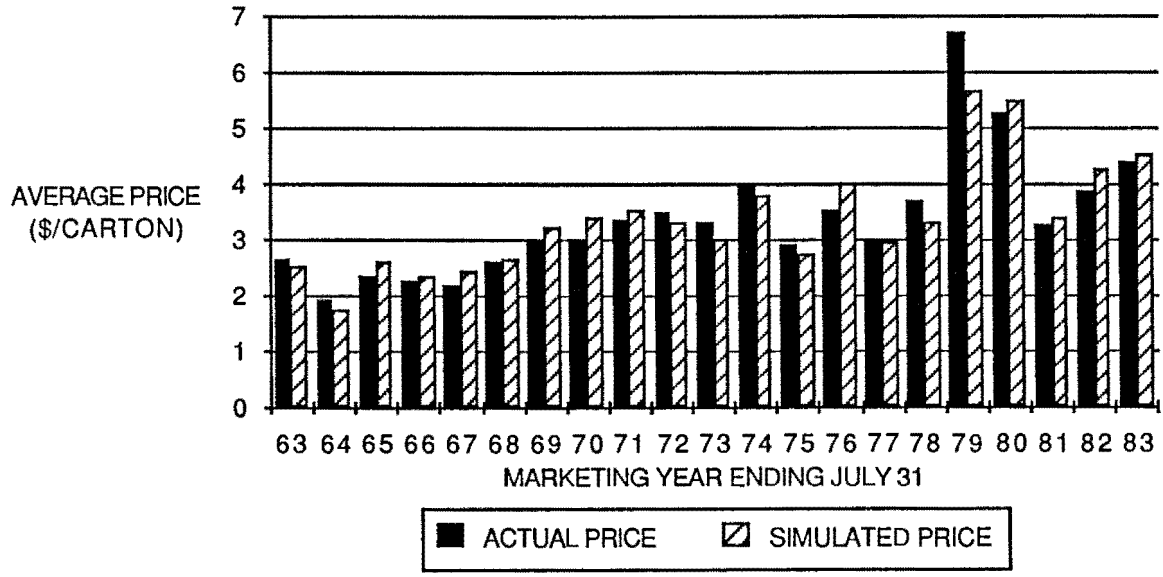
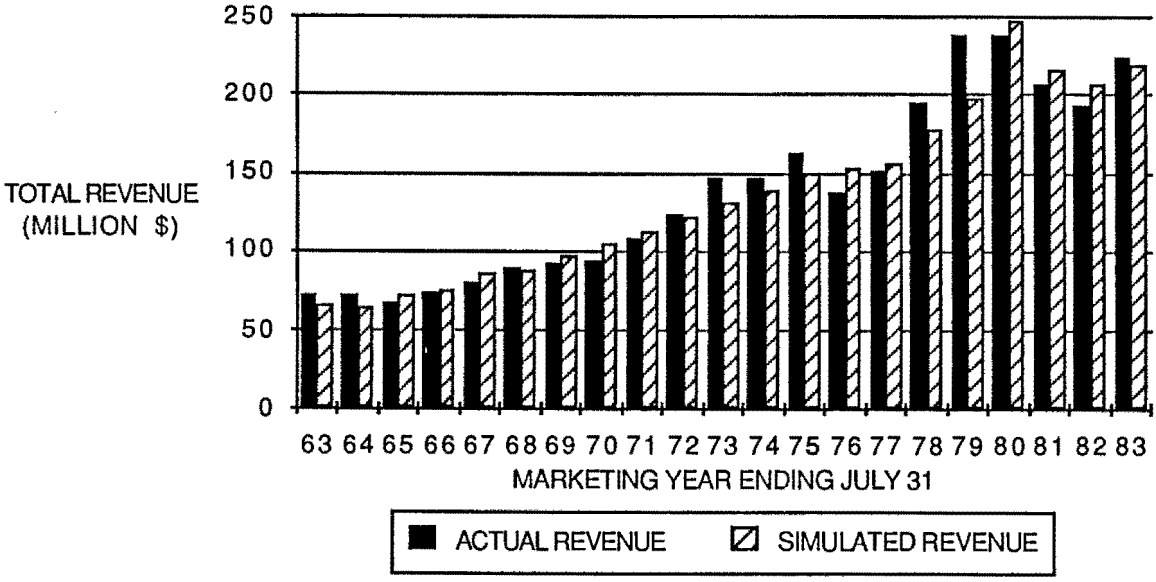


FIGURE 10. COMPARISON OF ACTUAL AND SIMULATED F.O.B. TOTAL REVENUE FOR CALIFORNIA-ARIZONA LEMONS, 1962-63 TO 1982–83



HISTORICAL SIMULATION OF ALTERNATIVE MARKETING POLICIES

The long-run impacts on the California-Arizona lemon industry of restricting fresh market shipments under the prorate provisions of the lemon marketing order have been questioned. As a measure of the impact of restricted fresh market shipments and the nature of industry adjustments, the simulation model was run with constant per capita allocations to the fresh market varying from 2.1 to 2.4 pounds for the 22-year period 1962-63 through 1983-84.[6] A constant fresh market allocation of 2.5 pounds per capita could not be maintained because of a large decrease in bearing acreage. With increasing population, per capita sales of 2.1 pounds resulted in fresh market allocations beginning at 11,108 cars in 1962-63 and increasing to 14,096 cars in 1983-84. Sales of 2.4 pounds per capita resulted in total fresh market sales beginning at 13,546 cars and ending at 17,191 cars. Actual sales to the fresh market during this period ranged from a low of 11,991 cars in 1974-75 to a high of 13,702 cars in 1963-64 (Appendix Table 5). As shown in Appendix Table 10, actual per capita consumption of fresh lemons varied from 1.8 to 2.6 pounds during the 22-year period of the simulation. Since 1967, however, fresh market allocations have ranged from 1.9 to 2.2 pounds per capita.

Simulated results for each level of fresh market allocation together with base simulation results are presented for bearing acreage, average f.o.b. prices, total revenue and deflated per acre returns. The nature of industry adjustments to each marketing policy provides information on the impact of the prorate provisions of the marketing order.

SIMULATED BEARING ACREAGE

Simulated bearing acreage adjustments to various constant per capita fresh market allocations are shown in Table 9. The base simulation results in the first column of the table are provided for comparison. Note that the base simulation uses actual fresh market allocations as shown in Appendix Table 5. Recall that the acreage adjustments shown are lagged responses to changing prices, yields, income tax provisions and price risk.

Actual fresh market allocations ranged from 2.3 to 2.6 pounds per capita during the first four years of the simulation. Thus, the initial observations for allocations of 2.1 to 2.4 pounds per capita result in higher all-use f.o.b. prices than the base simulation. These higher prices result in an unexpected initial decrease in bearing acreage because of increased price variability but later lead to bearing acreage above the base for the years 1969-1970 through 1981-82 for 2.1 pounds per capita and the years 1970-71 through 1976-77 for 2.2 pounds per capita.

The pattern of bearing acreage adjustments shown by the simulated results in Table 9 are both interesting and important. The most restrictive fresh market allocation of 2.1 pounds per capita tends to demonstrate the greatest variability over time and the highest acreages at the end of the simulation period. Likewise, the highest fresh market allocation (2.4 pounds per capita) has the lowest ending acreage and acreages are quite stable after 1970-71. Note in Table 9 that after the 1965-66 marketing year, simulated bearing acreage decreases as the fresh market allocation increases. The difference in bearing acreage for the 2.1 and 2.4 pounds per capita fresh market allocation increases from 625 acres in 1965-66 to 24,076 acres in 1977-78 and then decreases as bearing acreage under the 2.1 pound per capita alternative decreases. These patterns of changing bearing acreage combined with the fresh market allocations interact to determine prices, total revenue and returns per acre.

SIMULATED F.O.B. PRICES

Simulated production of lemons during a given crop year is proportional to bearing acreage since historic yields are employed in the simulation. The total production during a crop year is allocated to fresh, export and processed markets and the resulting f.o.b. prices are determined by the market demand equations. The average f.o.b. prices reported in Table 10 are a weighted average of prices in each market. While not reported here, an examination of simulated fresh market and export prices reveals that they are inversely related to the per capita fresh market allocation. Thus, fresh and export prices are highest each year for the scenario with 2.1 pounds per capita allocated to the fresh market and lowest for the scenario with 2.4 pounds per capita allocated to the fresh market.

During the first 10 years of the simulation, average prices are inversely related to the per capita fresh market allocation (Table 10). In year 11 (1972-73), average prices almost equalize for all scenarios. Then

6. As noted by reviewers, one would expect market allocations to be endogenous. Thus, it is unlikely that a particular constant fresh market allocation which was not profit maximizing would be continued for long periods as the simulation implies. By utilizing constant fresh market allocations, however, we are able to systematically demonstrate the impacts of a particular level of allocation on acreage, production and price response over time.

Table 9. Simulated Bearing Acreage of California-Arizona Lemons Given Constant Fresh Market Allocations Ranging from 2.1 to 2.4 Pounds Per Capita for the Period 1962-63 through 1983-84

Year	Base	Pounds per Capita 2.1	2.2	2.3	2.4
	acres				
1962-63	55,893	55,893	55,893	55,893	55,893
1963-64	53,782	52,544	52,752	53,107	53,519
1964-65	51,579	50,933	51,160	51,498	51,795
1965-66	49,458	50,750	50,721	50,550	50,125
1966-67	47,748	50,309	49,944	49,213	48,015
1967-68	47,006	49,279	48,497	47,208	45,287
1968-69	47,200	49,063	47,831	45,919	43,181
1969-70	48,487	50,400	48,666	46,030	42,304
1970-71	51,206	53,590	51,257	47,726	42,737
1971-72	55,347	58,011	54,990	50,400	43,839
1972-73	58,895	61,529	57,920	52,378	44,242
1973-74	61,069	63,368	59,461	53,356	44,093
1974-75	65,628	66,874	62,465	55,599	45,064
1975-76	69,585	69,432	64,865	57,761	46,694
1976-77	72,241	70,454	65,799	58,580	47,169
1977-78	74,840	71,943	67,119	59,700	47,867
1978-79	75,065	71,560	66,812	59,551	47,850
1979-80	75,644	70,786	66,043	58,851	47,121
1980-81	76,393	69,903	65,194	58,102	46,327
1981-82	75,573	68,426	64,249	57,923	47,122
1982-83	73,096	66,066	62,765	57,665	48,606
1983-84	70,232	63,297	60,753	56,753	49,350

Table 10. Simulated Average f.o.b. Prices for California-Arizona Lemons Given Constant Fresh Market Allocations Ranging From 2.1 to 2.4 Pounds Per Capita for the Period 1962-63 through 1983-84

Year	Base	Pounds per Capita 2.1	2.2	2.3	2.4
	dollars per carton				
1962-63	2.54	3.02	2.96	2.85	2.69
1963-64	1.75	2.21	2.17	2.07	1.94
1964-65	2.60	2.84	2.76	2.61	2.41
1965-66	2.35	2.51	2.43	2.30	2.13
1966-67	2.45	2.36	2.28	2.16	2.01
1967-68	2.68	2.60	2.51	2.39	2.23
1968-69	3.22	3.00	2.89	2.74	2.54
1969-70	3.38	3.14	3.03	2.89	2.68
1970-71	3.54	3.21	3.10	2.96	2.73
1971-72	3.31	2.94	2.87	2.77	2.59
1972-73	3.00	2.70	2.71	2.72	2.69
1973-74	3.80	3.34	3.32	3.29	3.21
1974-75	2.75	2.41	2.52	2.69	2.89
1975-76	4.00	3.70	3.73	3.79	3.80
1976-77	2.98	3.02	3.15	3.36	3.63
1977-78	3.32	3.40	3.56	3.80	4.16
1978-79	5.68	5.54	5.67	5.87	6.21
1979-80	5.48	5.52	5.60	5.72	5.91
1980-81	3.42	3.93	4.23	4.65	5.39
1981-82	4.25	4.89	5.22	5.70	6.53
1982-83	4.55	5.23	5.53	5.95	6.68
1983-84	5.85	6.60	6.88	7.24	7.91

in year 12, and for the remainder of the simulation, there is a positive relationship between average prices and the fresh market allocation. During this latter period, small quantities and higher prices in the processed market combined with the 2.4 pound per capita fresh market allocation yield a higher average price than does a 2.1 pound per capita fresh market allocation with large quantities sold for processing at relatively low prices.

This is an important result. It shows the significant effect of low processing returns on average f.o.b. price under conditions of large crops. Thus, lower fresh market allocations increase grower returns in the short run and result in increased acreage and production in the long run. The lower fresh market allocations result in increased diversions of lemons to processed uses at low prices as output expands, placing increased downward pressure on overall average prices.

SIMULATED INDUSTRY TOTAL REVENUE

The simulated total revenue reported for each scenario for each year in Table 11 is the sum of total revenues in current dollars from lemons sold in the fresh, export and processing markets. The scenarios which allocate lower quantities to the fresh market than what was actually marketed fresh, result in lower total revenues than for the base during most of the simulation period. From 1980-81 on, the base simulation provides a lower industry total revenue than all but the 2.4 pound scenario. Recall, however, that bearing acreage during the latter part of the simulation are lower for scenarios with the highest fresh market allocations. Adjustment for changing costs and acreage reveal a slightly different pattern of returns to lemon production.

SIMULATED REAL PER ACRE RETURNS

The simulated farm level returns per acre adjusted for changing costs of production are probably the best measure of economic adjustments affecting the individual lemon producer. Note in Table 12 that real returns per acre at the farm level tend to be highest for the most restricted fresh market sales during the first four years of the simulation. Then returns for the base simulation are the highest for years five through 14 except for 1974-75. For the last seven years of the simulation, returns are highest for the scenarios with the largest fresh market allocations. The pattern of real returns per acre in Table 12 are very similar to the pattern of f.o.b. prices shown in Table 10. A comparison of real returns per acre for each scenario indicates that the base scenario provides the highest returns 60 to 70 percent of the time when compared pairwise with each of the other alternatives. In addition, the more restrictive the fresh market allocation, the more variable are the real returns per acre (Table 12), with the base scenario demonstrating the most variable returns.

THE NO PRORATE ALTERNATIVE

Participants in the lemon marketing order hearings held in early 1984 discussed possible impacts on the California-Arizona lemon industry of terminating the fresh market prorate provisions of the order. Thus, a no prorate scenario has important policy implications. The simulation model developed in this study, however, is not appropriate for analyzing the industry in a nonregulated environment. Prorate termination would be expected to significantly alter marketing conditions from those existing during the period the model was estimated and there is no basis for constraining and/or revising the underlying econometric model. If policy changes affect the parameters of the basic model and these changes are not taken into account, then the subsequent simulations from the misspecified model are invalid, a problem known as the Lucas Critique (Lucas, 1982).

The approach taken in this study does not provide point estimates of the impacts of a no prorate scenario, but it does indicate the nature of the adjustments that could be expected to occur. The estimated simultaneous equations model was taken as given and the restrictive fresh market allocations were gradually relaxed. As the restrictions become less binding, the simulated results more closely approach the free market situation and the model results can be used as a basis for speculation on possible outcomes. An examination of the simulation model results indicates that the following scenario could be expected with termination of the fresh market prorate for lemons, given recent production levels of approximately 50,000 carloads:

- —There would be an immediate, significant decrease in average lemon prices as a higher proportion of the crop was allocated to the fresh market and a lower proportion to the processed outlet.
- —A reduction of bearing acreage of lemons would begin immediately in response to decreased farm level returns and the reduction would likely continue for some time. This lagged response would be due to both increased removals and decreased plantings. The total reduction in bearing acreage could approach one-third to one-half of current acreage.
- —Cyclical acreage, production and prices would be expected to continue without prorate. Thus, as bearing acreage and production decrease, prices for lemons would increase and reach a level which would stimulate new planting and production. When the new acreage reaches bearing age,

Table 11. Simulated Total Industry Revenue for California-Arizona Lemon Production. Constant Per Capita Fresh Market Allocations of 2.1 to 2.4 pounds. Marketing years 1962-63 to 1983-84.

Year	Base	Pounds per Capita 2.1	2.2	2.3	2.4
	acres				
1962-63	65.80	78.15	76.70	73.88	69.71
1963-64	63.69	78.75	77.44	74.64	70.35
1964-65	71.77	77.35	75.50	72.02	66.94
1965-66	74.26	81.52	78.84	74.44	68.35
1966-67	5.78	88.00	84.37	78.97	71.78
1967-68	87.33	89.05	84.62	78.34	70.03
1968-69	97.03	94.00	88.32	80.51	70.17
1969-70	103.82	100.31	93.58	84.29	71.76
1970-71	112.73	107.08	99.00	87.86	72.57
1971-72	121.77	113.28	104.78	92.83	75.57
1972-73	130.27	122.74	115.73	105.12	87.77
1973-74	138.15	125.91	117.35	104.64	84.15
1974-75	149.63	133.56	130.53	123.95	107.93
1975-76	152.84	140.95	132.88	120.07	97.51
1976-77	155.17	153.33	149.70	141.93	123.55
1977-78	177.94	175.18	170.98	162.29	142.35
1978-79	198.19	184.24	175.86	162.27	137.99
1979-80	247.28	232.94	220.57	200.91	166.00
1980-81	215.62	226.49	227.07	222.71	205.84
1981-82	207.50	215.87	216.75	213.05	198.72
1982-83	219.31	227.69	228.87	225.96	213.97
1983-84	251.56	255.76	255.66	251.38	238.94

Table 12. Simulated Farm Level Returns Per Acre for California-Arizona Lemon Production Given Constant Fresh Market Allocations Ranging From 2.1 to 2.4 Pounds Per Capita for the Period 1962-63 through 1983-84

Year	Base	Pounds per Capita 2.1	2.2	2.3	2.4
	dollars per acre, deflated				
1962-63	670	903	875	822	743
1963-64	536	869	836	770	674
1964-65	768	902	857	776	664
1965-66	721	829	776	691	578
1966-67	904	830	770	685	575
1967-68	983	932	870	785	671
1968-69	1,164	1,028	960	869	744
1969-70	1,261	1,119	1,056	970	843
1970-71	1,188	1,004	943	861	732
1971-72	811	594	552	497	393
1972-73	755	573	576	583	564
1973-74	888	684	674	665	626
1974-75	570	394	451	539	642
1975-76	678	583	594	611	616
1976-77	354	369	423	504	611
1977-78	270	300	358	446	577
1978-79	427	396	423	467	543
1979-80	582	592	612	644	690
1980-81	339	494	584	715	942
1981-82	245	384	459	563	746
1982-83	252	400	467	557	718
1983-84	440	589	643	715	849
Average	673	671	671	670	670

increased production will lead to decreased prices.

—The value of lemon groves would follow lemon price movements. They would first decrease after removal of prorate but would then be expected to increase when lemon prices began to increase.

—Comparison of prorate and no prorate alternatives for a given year are difficult because of the dynamic nature of cyclical adjustments. Termination of prorate would result in a changed pattern of acreage, production and prices with peaks and troughs which differ from the prorate alternative. Under current conditions, with an acreage reduction underway, one would expect termination of prorate to result in more rapid decrease in acreage, a lower minimum amount of bearing acreage and a slower recovery of acreage than with prorate.

—For any given level of production, the no prorate alternative would be expected to result in lower average fresh market prices, higher prices for lemons going to the processed outlet and lower average prices for the total crop. Because of lower average prices, we would expect average production over time to be lower with the no prorate than with the prorate alternative.

PROJECTIONS WITH ALTERNATIVE FRESH MARKET ALLOCATIONS

While historical simulations are of interest in demonstrating how alternative marketing policies have affected the industry, they provide little information about how these policies would affect present and future industry and consumer welfare. Therefore, the simulation model is used to project the future impacts of alternative fresh market allocations. While the behavioral relationships estimated here may change somewhat over the next 10-15 years, these projections can provide a guideline to industry committee members and policy makers concerning general long-run impacts. These simulations were accomplished by projecting values for exogenous and policy variables over the chosen planning horizon, and letting the model predict the resulting values of its endogenous variables. Policies analyzed included a set of constant per capita fresh market allocations, ranging from 2.05 pounds to 2.5 pounds per capita, as well as a set of annual fresh market allocations ranging from 12,000 to 20,000 cars, each of which was held constant over the projection period.

Growth assumptions for the exogenous variables were based on historical trends and recent developments in population, prices, and output. For the projections, real industrial GDP is assumed to grow at an annual rate of 2.0 percent over the projection period. U.S. nominal disposable income increases at an annual rate of 4.5 percent, while prices as measured by the producers price index increase 3.5 percent annually. U.S. and Canadian population is assumed to grow 1.2 percent annually, while industrial country population grows 0.67 percent annually. Lemon yields are assumed to continue their historical upward trend.

Annual projections of bearing acreage, average f.o.b. prices and farm level total revenue per acre for California-Arizona lemons, based on the scenarios described above, are presented for the 1984-85 through 1998-99 crop years. Our discussion will focus on the bearing acreage projections for this 15-year period; because of the use of smooth and increasing per acre yields, the series for prices and per acre revenue are closely related to bearing acreage. Note that the confidence which one can place on the acreage projections (as well as price and total revenue projections) decreases with time.

Bearing acreage projections for constant per capita domestic fresh market allocations ranging from a base of 2.05 pounds to 2.5 pounds are presented in Table 13. Bearing acreage continues its recent decrease for each alternative, reaching a minimum ranging from 53,090 to 56,575 acres in the 1991-92 marketing year. Then, bearing acreage begins to increase, with the amount of increase by the end of the projection period dependent on fresh market allocations. In general, the less restrictive the fresh market allocation, the lower the projected increase in bearing acreage. This pattern is due to the inverse relationship between fresh market allocations and prices, and the direct relationship between prices and plantings, during the period when acreage is decreasing. Projections of average f.o.b. prices and revenue per acre are presented in Appendix Tables 12 and 13. If the projections were to be continued past the 15-year period shown, bearing acreage would reach another peak, with the earliest peak occurring for the most restrictive fresh market allocations. Given the population projections used, 1998-99 fresh market allocations would range from 17,250 cars for 2.05 pounds per capita to 20,535 cars for 2.5 pounds per capita.

An alternative scenario of constant annual fresh market allocations ranging from 12,000 to 20,000 cars resulted in the projected bearing acreages shown in Table 14. Note that the base projection in Tables 13 and 14 is the same and that it involves a constant allocation of 2.05 pounds per capita. Constant fresh market allocations of 12,000 to 18,000 cars annually again result in minimum bearing acreage occurring in 1991-92, while the minimum bearing acreage for an annual allocation of 20,000 cars is delayed until 1992-93. With the population projections utilized, the 20,000 car fresh market allocation is equivalent to 2.88 pounds per capita in 1984-85, decreasing to 2.43 pounds per capita in 1998-99. Projections of f.o.b. prices and farm

Table 13. Projected Bearing Acreage of California-Arizona Lemons Given Constant Fresh Market Allocations Ranging from 2.1 to 2.5 Pounds Per Capita, 1984-85 through 1998-99 Marketing Years.

Marketing Year	Fresh Market Allocation, lbs./capita					
	Base	2.1	2.2	2.3	2.4	2.5
	bearing acreage					
1984-85	66,502	66,502	66,502	66,502	66,502	66,502
1985-86	63,492	63,492	63,477	63,439	63,373	63,271
1986-87	61,312	61,315	61,255	61,104	60,851	60,478
1987-88	59,718	59,730	59,629	59,359	58,908	58,258
1988-89	58,627	58,651	58,520	58,146	57,516	56,613
1989-90	57,634	57,665	57,502	57,034	56,247	55,120
1990-91	56,713	56,746	56,552	56,005	55,088	53,773
1991-92	56,539	56,575	56,346	55,705	54,631	53,090
1992-93	57,427	57,474	57,215	56,474	55,225	53,430
1993-94	59,378	59,443	59,167	58,331	56,905	54,847
1994-95	61,797	61,897	61,630	60,721	59,139	56,838
1995-96	64,275	64,429	64,226	63,321	61,680	59,255
1996-97	66,671	66,892	66,796	65,959	64,346	61,908
1997-98	68,889	69,189	69,234	68,519	67,008	64,650
1998-99	70,813	71,204	71,431	70,893	69,553	67,363

Table 14. Projected Bearing Acreage of California-Arizona Lemons Given Constant Fresh Market Allocations Ranging from 12,000 to 20,000 carloads Annually, 1984-85 through 1998-99 Marketing Years

Marketing Year	Fresh Market Allocation, Carloads					
	Base	12,000	14,000	16,000	18,000	20,000
	bearing acreage					
1984-85	66,502	66,502	66,502	66,502	66,502	66,502
1985-86	63,492	63,354	63,489	63,438	63,139	62,309
1986-87	61,312	60,711	61,294	61,118	60,075	57,621
1987-88	59,718	58,509	59,664	59,425	57,682	53,884
1988-89	58,627	56,769	58,517	58,310	56,018	51,047
1989-90	57,634	55,184	57,452	57,328	54,652	48,739
1990-91	56,713	53,737	56,437	56,441	53,551	46,966
1991-92	56,539	52,920	56,129	56,269	53,105	45,732
1992-93	57,427	52,991	56,833	57,146	53,674	45,451
1993-94	59,378	53,954	58,542	59,090	55,329	46,290
194-95	61,797	55,152	60,616	61,504	57,554	47,844
1995-96	64,275	56,219	62,593	64,019	60,257	50,488
1996-97	66,671	57,080	64,339	66,445	63,194	53,890
1997-98	68,889	57,636	65,751	68,641	66,150	57,705
1998-99	70,813	57,699	66,687	70,465	68,952	61,696

level revenue per acre for these constant fresh market allocations are presented in Appendix Tables 14 and 15.

The projections developed in this study indicate that the annual fresh market allocations made by the Lemon Administrative Committee under the marketing order prorate provisions can have long-term impacts on bearing acreage and production. Because of extensive lagged adjustments to prices and profitability, fresh market allocations which are relatively large or small over a sustained time period appear to lead to wider swings in acreage and production than would a middle-of-the-road allocation. Thus, while a very restrictive fresh market allocation results in the highest short-term fresh market prices and farm level total revenue, the resulting supply response makes it harder and harder to maintain farm level returns per acre because of the increasing quantities which must be diverted to the processing market at very low prices.

Each of the projection scenarios indicates that California-Arizona bearing acreage of lemons will decrease during the next several years. This result is largely due to low plantings of new lemon trees during the last several years of relatively low lemon prices and profits. Current nonbearing acreage (1,594 acres as of January 1, 1985) is below that needed to maintain lemon acreage, given a normal level of removals. While farm level returns for lemons are expected to improve over the next several years, the industry will need to carefully monitor new plantings and be aware of their future impact if a return to high production levels and low profits is to be forestalled.

CONSUMER WELFARE IMPACTS[7]

Marketing policies such as the lemon prorate have impacts on both consumers and producers. These impacts are typically evaluated through the calculation of estimated changes in consumer and producer surplus where the marketing program is compared with a "free market" situation, see, e.g. LaFrance and deGorter (1985) and Minami, French, and King (1979). As explained earlier, we did not examine a free market situation but instead concentrated on scenarios in which the fresh market allocation was varied. Thus, we cannot estimate the impact of the lemon prorate on consumers and producers; we only provide estimated changes in consumer surplus and producer revenue as fresh market allocations are varied.

A standard measure of consumer surplus is the area under the price dependent demand curve above the point of intersection with the supply function. Following Minami, French, and King (1979), changes in consumer surplus from the base policy relative to the current marketing policy may be expressed as

$$\Delta CS = \tfrac{1}{2} (P_C - P_B) \bullet (Q_C + Q_B)$$

where P_C and P_B are f.o.b. prices of lemons for the current policy and the base policy, respectively and Q_C and Q_B and are the quantities of lemons associated with the current and base marketing policies, respectively. Two base policies were utilized in this study. The first was the actual per capita fresh market allocation, as shown in Appendix Table 10, for the years 1962-63 through 1983-84. The second base policy, used for projections for the years 1984-85 through 1998-99, was a constant fresh market allocation of 2.05 pounds per capita.

If the f.o.b. to retail marketing margin is constant for different price levels, then the above measures are reasonable approximations of the actual changes in consumer surplus at the retail level. If, however, there are percentage components in the f.o.b. to retail margin such that the margin is a positive function of price, then the consumer surplus changes measured at the f.o.b. level will be less than those measured at the retail level. This study did not analyze the components of and behavior of f.o.b. to retail margins but it is likely that they contain at least a small component of percentage charges. There is also a problem associated with differing margins for fresh and processed products, since processing costs are part of the f.o.b. to retail margin for processed products while sorting and packing costs are part of the farm to f.o.b. margin for fresh lemons. For most of the estimated changes in consumer surplus in this study, there was an inverse relationship between the changes in consumer surplus for fresh lemons and for processed lemons, i.e., an increase in consumer surplus for the fresh market was usually partially offset by a decrease in consumer surplus for processed products. Thus, margin behavior could easily alter the estimated aggregate changes in consumer surplus measured at the f.o.b. level in this study from similar changes measured at the retail level.

Estimated changes in consumer surplus for fresh lemons sold on the domestic market and for processed lemons were calculated for each of the simulation scenarios for the 1962-1984 period and for each of the projections for the 1984-1999 period. Results for each of the two periods are discussed in turn. We do not estimate consumer surplus for fresh lemons which are exported but the direction of change in consumer surplus would be similar to fresh market changes since

7. It is well known that welfare measures depend upon the dynamic adjustment paths. This follows from the condition that the value of line integrals are not invariant to the adjustment paths. However, a dynamic approach is beyond the scope of this analysis. See, for example, Berck and Perloff (1985) for a recent discussion of the welfare biases that may arise from using static techniques. Also see LaFrance and deGorter (1985) for alternative methods of computing economic costs using a dynamic econometric model of the U.S. dairy market.

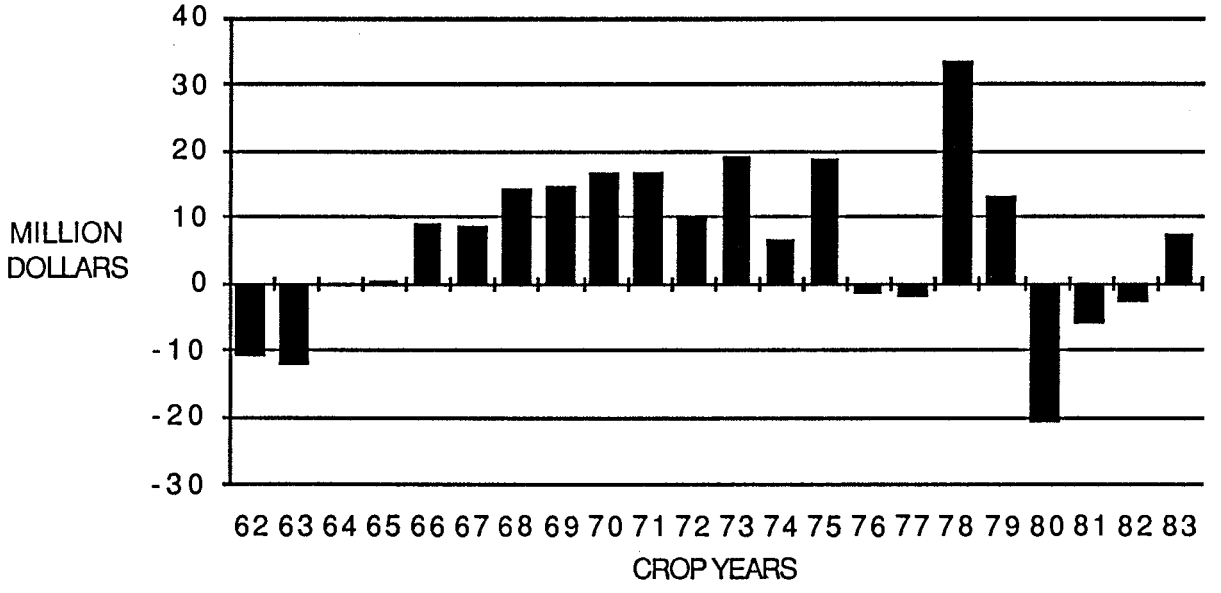
the export price in our model is dependent on the fresh market price. Note that these estimated changes in consumer surplus are overstated for U.S. consumers because the weekly fresh market prorate allocation of lemons is for both the U.S. and Canadian markets.

The actual annual fresh market allocation was used as the base for the 1962-1984 simulations. Estimated changes in consumer surplus from the base simulation are presented for fresh market allocations of 2.1, 2.2, 2.3, and 2.4 pounds per capita in Appendix Tables 16, 17, 18, and 19. A comparison of the actual fresh market allocation, as presented in Appendix Table 10, and the constant per capita allocation used for each simulation helps to explain the pattern of calculated changes in consumer surplus. Calculated changes in consumer surplus for a moderate policy, that of allocating 2.3 pounds per capita to the fresh market, are shown in Figure 11. Note that the actual fresh market allocations for the first four crop years of the simulation were greater than 2.3 pounds per capita. As a result, the change in consumer surplus for the fresh market is negative for the first four years of the simulation while the change in consumer surplus for the processed market is positive (Appendix Table 18). Gains in consumer surplus from increased fresh market allocations with lower fresh market prices are typically partially offset by losses in consumer surplus from lower processed allocations at higher prices and vice-versa. The losses in consumer surplus toward the end of the simulation period are the result of reduced acreage and production (relative to the base) due to acreage response to lower prices and returns during early years of the simulation. The average annual increase in consumer surplus from a constant fresh market allocation of 2.3 pounds per capita for the 1962-63 through 1983-84 period was $5.9 million.

Consumer surplus increases with increases in fresh market allocation for each of the simulation scenarios during the 1962-63 through 1983-84 period (Appendix Tables 16, 17, 18, 19). The average annual increase in consumer surplus relative to the base was: 2.1 pounds per capita, $0.40 million; 2.2 pounds per capita, $3.18 million; 2.3 pounds per capita, $5.90 million; and 2.4 pounds per capita, $9.26 million.

Estimated changes in consumer surplus relative to a base allocation of 2.05 pounds per capita for 1984-85 through 1998-99 projections with fresh market allocations of 2.1, 2.3, and 2.5 pounds per capita are presented in Appendix Tables 21, 22, and 23. Increased fresh market allocations result in increased consumer surplus, with the increased annual consumer surplus averaging $4.70 million for 2.1 pounds per capita, $24.21 million for 2.3 pounds per capita, and $45.53 million for 2.5 pounds per capita.[8] Thus, both historical and projected simulation results indicate that domestic consumers benefit from less restrictive fresh market allocations since consumer surplus gains in the fresh market more than offset losses in the processed market.

FIGURE 11. ESTIMATED CHANGES IN CONSUMER SURPLUS, CONSTANT FRESH MARKET ALLOCATION OF 2.3 POUNDS PER CAPITA, 1962-63 TO 1983-84.



8. These projections assume that all lemons are utilized. With on-tree certification it is possible that some lemons would not be harvested if returns for processing were too low to cover costs of harvest and transportation. If this occurred, consumer surplus in the processed outlet would be overstated and the estimated changes would have to be modified.

As noted by Minami, French and King (1979, p. 93), it is not possible to compute a measure of producer surplus in the usual sense. They did, however, compute a measure of changes in net returns which they viewed in the context of economic rent. We follow a similar procedure but with additional assumptions. We estimated total returns to producers but did not have cost data needed to estimate net returns. Changes in total returns will be equivalent to changes in net returns if one assumes that total costs do not change as the mix between fresh and processed use changes.

Estimated changes in total returns to producers at the f.o.b. level under the alternative fresh market allocations include total revenue from fresh market, export market and processed market sales. These estimates for the 1962-63 through 1983-84 period are shown in Appendix Table 20. Increased fresh market allocations generally resulted in decreased producer returns, and average returns over the analytical period decreased as the fresh market allocations increased. Average annual decreases in total revenue relative to the base were: 2.1 pounds per capita, -$1.21 million; 2.2 pounds per capita, -$5.62 million; 2.3 pounds per capita, -$13.48 million; and 2.4 pounds per capita, -$28.03 million. Note that average deflated total revenue per acre over the total simulation period was almost the same for each of the four simulations (Table 12). Thus, the reductions in total industry revenue appear to be due to reduced bearing acreage for the scenarios with higher fresh market allocations.

Projected changes in producer total revenue as fresh market allocations are increased from a base of 2.05 pounds per capita to a range of 2.1 to 2.5 pounds per capita for the marketing years 1984-85 through 1998-99 are shown in Appendix Table 24.

The pattern of change in total revenue during the early years of the projection is for total revenue to decrease as the fresh market allocation increases up through 2.5 pounds per capita. Because of the nature of acreage, production, and price responses, however, the pattern of changes in total revenue is reversed for the last year of the projection. For 1998-99, total revenue increases with each increase in the fresh market allocation through 2.5 pounds per capita. The average annual changes in f.o.b. total revenue for the 15-year projection period by fresh market allocation were: 2.1 pounds per capita, $1.93 million; 2.2 pounds per capita, $3.54 million; 2.3 pounds per capita, $2.00 million; 2.4 pounds per capita, -$2.91 million; and 2.5 pounds per capita, -$11.52 million. This pattern would be expected to change as the length of the projection period changed.

CONCLUDING COMMENTS

This study includes information and analysis which answers many of the economic questions raised during the 1984 lemon marketing order hearings. Some questions, however, were outside the scope of this study and their answers will depend on further research. Following is a brief discussion of major topics covered by the research, some conclusions based on the results and some areas which require further analysis.

Many questions asked about the lemon industry and its marketing policy relate to price elasticity or price flexibility of demand. Price flexibility measures the responsiveness of prices to changes in quantity and other factors. The empirical analysis of demand yielded results which are consistent with earlier studies. The price flexibility of demand for fresh lemons is quite high (price inelastic) at the f.o.b. level. As a result, prices are very responsive to changes in the quantity of lemons allocated to the fresh market. Marketing margins are not very responsive to changes in the price of lemons, with the result that retail price adjustments due to changing fresh market allocations are passed rather directly through to the producer level. Increased fresh market sales in response to high levels of production result in decreased (not increased) short-run total industry revenue. The estimated f.o.b. processing demand equation yields an estimated flexibility coefficient of -.47 at mean values (price elasticity = -2.11). Thus, f.o.b. processing prices respond very little to changes in the quantity of processed lemons. The estimated price elasticity of demand for export lemons of -.96 indicates that the proportional change in export quantity is about equal to the proportional change in the exchange rate adjusted export price at mean values.

Data from the USDA's household food consumption survey indicate a rather significant decrease in fresh lemon use at the household level during the period 1965-66 to 1977-78. Aggregate fresh consumption data for the same period, however, suggest that fresh lemon sales were nearly constant in per capita terms. Thus, there appears to have been a shift in consumption from households to institutional outlets. This topic, which has important implications for the design of marketing programs, requires further investigation.

The analysis of lemon acreage response to changing economic conditions provides further verification of the existence of cyclical patterns of price and produc-

tion. Because of the extensive lags between planting decisions and the resulting production, full adjustment to changed economic conditions requires at least 10 years. Overadjustment, together with exogenous shocks, lead to the cyclical behavior.

The estimated simulation model demonstrates that allocations to the fresh market have long-run implications related to acreage and production response. Analysis of various lemon marketing policies consisting of different per capita fresh market allocations indicate that the more restrictive the fresh market allocation, the greater will be average bearing acreage and production. In addition, more restrictive fresh market allocations are related to greater cyclical variation of acreage, production and prices. The fresh market prorate is a powerful tool. It can be used to stabilize or destabilize the industry. Exogenous events, such as freezes, changing government tax policies, commodity programs and changing marketing opportunities can also have long-lasting impacts on the industry.

Some critics of the lemon marketing order have charged that the prorate provisions lead to chronic overproduction and excess productive capacity. The fresh market allocation scenarios which were simulated indicate that it is not the prorate *per se* but the way in which it is utilized which determines long-run lemon acreage, production and prices. The present industry situation is the product of restrictive fresh market allocations followed over a decade ago.

Nonbearing acreage of California-Arizona lemons is low in response to several years of low returns and, as a result, bearing acreage will continue to decrease for several years, regardless of fresh market allocations. New plantings of lemons will begin as returns improve. Projections indicate that these new plantings will be large enough to counteract removals after 1991-92 in most of the scenarios. Thus, bearing acreage will reach a low point in 1991-92 and then begin to increase as new plantings begin bearing. The larger the fresh market allocation and the lower are average prices during the contraction phase (until 1991-92), the larger the reduction in bearing acreage. Regardless of the fresh market allocation, however, price increases associated with decreasing acreage will eventually lead to new plantings and an eventual increase in bearing acreage. While fresh market allocations can influence cyclical acreage, production and prices in the lemon industry, it is unlikely that marketing policy can ever eliminate cyclical behavior.

An analysis of changes in consumer surplus and producers' revenue in response to changing fresh market allocations indicates that as the fresh market allocation increases, consumer surplus for fresh lemons increases and consumer surplus for processed lemons decreases. The usual result of an increase in the fresh market allocation is a net increase in consumer surplus in the short run but this can become a net decrease in consumer surplus with acreage adjustments which occur over a longer period. Simulations over the historical period indicated that average producer total revenue at the f.o.b. level decreased more than consumer surplus increased at the f.o.b. level. For the projections, however, there was a range of increases in fresh market allocations over the base of 2.05 pounds per capita in which average f.o.b. consumer surplus and total producer revenue each increased, and the gain in consumer surplus from increased fresh market allocations always offset any loss in producer revenue.

This study does not address the question of the impact of changing acreage on industry structure. A separate sample survey of growers would be required to determine if acreages would change uniformly by farm size or if changes would be concentrated in particular size categories. Factors, which may vary by farm size category, such as crop mix, sources of income, grove age, grove productivity and financial structure may be related to individual farm acreage adjustments.

As a final note, readers are reminded that the lemon industry model specified and estimated in this study is a very simple representation of a complex industry. With additional research effort it can be further refined and utilized to evaluate other scenarios. The model can also be started at different points in time and the length of the simulation can be varied. Model refinements related to improving the acreage response relationship, disaggregating the export demand equation, and explicitly incorporating dynamic elements in the supply and demand relationships, could improve the performance of the simulation model. Seasonal demand relationships are important, especially in light of decreasing acreage over time in District 2, which produces summer lemons and increasing acreage in Districts 1 and 3, which produce the majority of their output during the winter months. Regional acreage response relationships and/or improved data on plantings and removals could help to better match the simulated series with actual industry performance. An examination of the demand for imported lemons in each of the major importing countries would appear to be worthwhile and could improve the specification of the simultaneous model of lemon demand.

APPENDIX TABLES

Appendix Table 1. California-Arizona Bearing and Nonbearing Lemon Acreage by District and Total, 1953-1985

As of January	All Districts			Central (District 1)			Southern (District 2)			Desert (District 3)		
	Bearing	Non-Bearing	Total	Bearing	Non-Bearing	Total	Bearing	Non-Bearing	Total	Bearing	Non-Bearing	Total
1953	58,138	5,756	63,894	1,241	?	1,241	56,323	5,741	62,064	574	15	589
1954	58,453	5,372	63,825	1,287	25	1,312	56,465	5,224	61,689	701	123	824
1955	57,160	6,679	63,839	1,246	20	1,266	55,055	6,403	61,458	859	256	1,115
1956	56,575	6,932	63,507	1,322	75	1,397	54,421	6,625	61,046	832	232	1,064
1957	56,460	10,589	67,049	1,457	118	1,575	53,438	7,871	61,309	1,565	2,600	4,165
1958	57,358	13,239	70,597	1,457	148	1,605	54,113	9,203	63,316	1,788	3,888	5,676
1959	58,086	11,744	69,830	1,523	36	1,559	53,362	8,558	61,920	3,201	3,150	6,351
1960	59,983	9,305	69,288	1,675	83	1,740	54,314	8,813	63,127	4,012	400	4,421
1961	60,073	7,615	67,688	1,781	68	1,869	53,396	7,291	60,687	4,896	236	5,132
1962	57,431	3,854	61,285	1,713	78	1,791	50,148	3,616	53,764	5,570	160	5,730
1963	57,592	2,856	60,448	1,983	10	1,993	48,614	2,276	50,890	6,995	570	7,565
1964	54,872	1,837	56,709	1,883	35	1,918	46,123	1,789	47,912	6,866	13	6,879
1965	53,225	2,691	55,916	1,702	350	2,052	43,934	1,852	45,786	7,589	489	8,078
1966	50,538	4,511	55,049	1,764	555	2,319	41,242	2,215	43,456	7,532	1,742	9,274
1967	48,484	7,409	55,893	1,754	1,001	2,755	39,126	2,678	41,804	7,604	3,730	11,334
1968	48,535	13,439	61,974	2,014	2,776	4,790	38,770	4,340	43,110	7,751	6,323	14,074
1969	47,902	17,498	67,400	1,989	3,135	5,124	37,840	4,427	42,267	8,073	9,936	18,009
1970	49,067	19,039	68,106	2,517	3,172	5,689	36,105	4,206	40,311	10,445	11,661	22,106
1971	51,893	20,674	72,540	3,211	3,757	6,968	37,176	4,661	41,837	11,506	12,229	23,735
1972	53,119	22,670	75,789	3,617	4,196	7,813	37,339	4,755	42,094	12,163	13,719	25,882
1973	59,509	22,647	82,156	4,971	4,824	9,795	38,002	4,522	42,524	16,536	13,301	29,837
1974	62,322	23,802	86,127	5,127	5,402	10,529	39,165	4,367	43,532	18,030	14,033	32,063
1975	67,117	23,967	91,081	5,830	5,809	11,639	38,926	6,594	45,520	22,361	11,561	33,922
1976	70,495	20,821	91,316	7,193	4,191	11,384	39,616	5,929	45,545	23,686	10,701	34,387
1977	69,733	15,739	85,472	7,704	3,683	11,387	38,032	5,326	43,358	23,997	6,730	30,727
1978	73,258	8,469	81,727	9,442	1,959	11,401	36,072	3,268	39,340	27,744	3,242	30,986
1979	76,423	3,811	80,234	9,773	1,407	11,180	37,558	1,506	39,064	29,092	898	29,990
1980	75,937	1,936	77,873	10,529	461	10,990	37,630	1,153	38,783	27,778	322	28,100
1981	76,794	1,016	77,810	10,891	133	10,952	37,782	717	38,499	28,193	166	28,359
1982	75,655	1,742	77,397	10,785	149	10,934	37,325	1,333	38,658	27,545	260	27,805
1983	71,263	2,237	73,500	10,095	165	10,200	35,171	1,672	36,843	25,997	400	26,397
1984	67,818	2,107	69,925	9,921	165	10,086	32,445	1,562	34,007	25,452	380	25,832
1985	65,235	1,594	66,829	9,388	128	9,516	31,791	1,111	32,902	24,056	355	24,411

Source: Annual Reports of the Lemon Administrative Committee.

Appendix Table 2. California-Arizona Lemons: Average Yields by District, 1955-56 through 1984-85 Crop Years

Season	District 1 Average Yield	District 2 Average Yield	District 3 Average Yield	Industry Average Yield
	cartons per acre			
1955-56	467	459	429	462
1956-57	510	569	378	563
1957-58	565	590	509	588
1958-59	648	584	345	586
1959-60	603	587	584	587
1960-61	343	501	230	475
1961-62	438	564	569	561
1962-63	264	508	153	456
1963-64	315	707	547	674
1964-65	593	574	334	541
1965-66	650	634	555	623
1966-67	768	723	769	732
1967-68	229	655	894	676
1968-69	508	601	939	654
1969-70	669	633	570	622
1970-71	444	656	602	631
1971-72	505	657	569	627
1972-73	441	840	616	744
1973-74	209	694	394	567
1974-75	517	972	778	868
1975-76	495	626	299	503
1976-77	458	835	564	706
1977-78	626	792	573	688
1978-79	261	526	550	501
1979-80	508	712	346	550
1980-81	813	900	705	816
1981-82	603	651	677	654
1982-83	673	789	507	668
1983-84	474	778	452	611
1984-85	681	884	689	783

Source: Based on Annual Reports of the Lemon Administrative Committee.

Appendix Table 3. Estimated Market Value of Bearing Lemon Groves and Irrigated Land, San Joaquin Valley, and Orchard Cost of Production Index, 1962-1984.

Year	Estimated Market Value[a] Lemons	Irrigated Land	Orchard Production Cost Index[b]
	dollars per acre		1967=1.00
1962	2150	1060	.86
1963	2675	1124	.87
1964	2800	1230	.90
1965	3100	1207	.92
1966	3625	1225	.99
1967	2950	1175	1.00
1968	3300	1185	1.05
1969	3450	1200	1.10
1970	3425	1165	1.12
1971	2965	1120	1.20
1972	3170	1135	1.25
1973	N/A	1210	1.37
1974	N/A	1460	1.67
1975	3150	1610	1.92
1976	3400	1680	2.05
1977	3350	1900	2.21
1978	3300	2265	2.35
1979	4250	2650	2.69
1980	5900	3545	3.14
1981	6950	4190	3.41
1982	6440	4570	3.53
1983	6850	4660	3.65
1984	6610	4360	

[a]Source: Farm Real Estate Market Developments, U.S. Department of Agriculture, Economic Research Service, Annual Issues.

[b]From Hardesty and Carman (1982).

Appendix Table 4. Composition of California-Arizona Lemon Production Districts

District 1 (CA)	District 2 (CA)	District 3 (CA and AZ)
Fresno	Los Angeles	Imperial (CA)
Kern	Orange	Riverside (CA)[a]
Kings	San Bernardino	Maricopa (AZ)
Madera	San Diego	Yuma (AZ)
Merced	San Luis Obispo	
Monterey	Santa Barbara	
San Benito	Ventura	
San Mateo		
Santa Cruz		
Stanislaus		
Tulare		

[a]All of Riverside County, including area that is located in District 2.

Source: A map and description of the districts is included in each annual report of the Lemon Administrative Committee.

Appendix Table 5. California-Arizona Lemons: Utilization by Market Outlet, 1955-56 through 1984-85 Seasons

Season	Fresh Movement			Processed[b]	Total
	Domestic[a]	Export	Total		
	carlot equivalents[c]				
Season (November-October)					
1955-56	14,918	3,465	18,383	8,605	26,988
1956-57	14,867	3,923	18,790	12,748	31,538
1957-58	14,283	6,045	20,328	13,641	33,969
1958-59	14,723	3,461	18,184	17,922	36,106
1959-60	13,981	4,367	18,348	17,322	35,670
1960-61	13,977	4,969	18,946	9,450	28,396
1961-62	13,985	3,755	17,740	14,813	32,553
1962-63	13,606	5,099	18,705	8,311	27,016
1963-64	13,702	5,199	18,901	18,136	37,037
1964-65	12,995	4,818	17,813	10,724	28,537
1965-66	13,012	5,583	18,595	13,515	32,110
1966-67	12,419	6,179	18,598	17,309	35,907
1967-68	12,713	6,331	19,044	15,009	34,053
1968-69	12,135	5,200	17,335	13,263	30,598
Season (August-July)					
1969-70	12,098	6,365	18,463	11,841	30,304
1970-71	11,875	6,285	18,160	12,443	30,603
1971-72	12,008	8,101	20,109	14,866	34,975
1972-73	12,206	9,885	22,091	22,890	44,981
1973-74	12,358	9,944	22,302	13,252	35,554
1974-75	11,931	11,011	22,942	35,528	58,470
1975-76	11,991	9,835	21,826	13,226	35,052
1976-77	12,529	13,149	25,678	25,413	51,091
1977-78	13,029	11,382	24,411	27,616	52,027
1978-79	12,037	11,762	23,799	15,313	39,112
1979-80	12,115	9,282	21,397	20,069	41,466
1980-81	13,030	9,774	22,804	40,767	63,571
1981-82	12,871	7,820	20,691	29,367	50,058
1982-83	13,632	8,636	22,268	26,288	48,556
1983-84	13,422	8,871	22,293	19,153	41,446
1984-85	13,999	9,054	23,053	28,008	51,061

[a]Includes shipments to Canada.
[b]Includes small quantities eliminated.
[c]Varying car loadings converted to standard carlots of 1,000 cartons.

Source: Annual reports of the Lemon Administrative Committee.

Appendix Table 6. California-Arizona Lemons: Percentage Utilization by Market Outlet 1955-56 through 1984-85 Seasons

Season	Fresh			Processed[b]	Total
	Domestic[a]	Export	Total		
	percent				
Season (November-October)					
1955-56	55	13	68	32	100
1956-57	47	12	59	41	100
1957-58	42	17	59	41	100
1958-59	40	10	50	50	100
1959-60	39	12	51	49	100
1960-61	49	17	66	34	100
1961-62	42	12	54	46	100
1962-63	50	19	69	31	100
1963-64	36	15	51	49	100
1964-65	45	17	62	38	100
1965-66	40	17	57	43	100
1966-67	34	17	51	49	100
1967-68	37	18	55	45	100
1968-69	39	17	56	44	100
Season (August-July)					
1969-70	40	21	61	39	100
1970-71	39	20	59	41	100
1971-72	34	23	57	43	100
1972-73	27	22	49	51	100
1973-74	35	28	63	37	100
1974-75	20	19	39	61	100
1975-76	34	28	62	38	100
1976-77	24	26	50	50	100
1977-78	25	22	47	53	100
1978-79	31	30	61	39	100
1979-80	29	22	51	49	100
1980-81	20	15	35	65	100
1981-82	26	15	41	59	100
1982-83	28	18	46	54	100
1983-84	32	22	54	46	100
1984-85	27	18	45	55	100

[a]Includes shipments to Canada.
[b]Includes small quantities eliminated.

Source: Derived from annual reports of the Lemon Administrative Committee.

Appendix Table 7. California-Arizona Lemons: Distribution of Total Production to Market Outlets by District 1955-56 through 1984-85 Seasons

Season	Domestic[a]				Export				Processed[b]			
	Dist. 1	Dist. 2	Dist. 3	Total	Dist. 1	Dist. 2	Dist. 3	Total	Dist. 1	Dist. 2	Dist. 3	Total
	carlot equivalents[c]											
Season (November-October)												
1955-56	423	14,248	247	14,918	15	3,448	2	3,465	209	8,175	221	8,605
1956-57	514	14,021	332	14,867	7	3,911	5	3,923	213	12,255	280	12,748
1957-58	404	13,489	391	14,283	103	5,927	15	6,045	298	12,780	562	13,641
1958-59	578	13,667	478	14,723	22	3,384	54	3,461	426	16,910	588	17,922
1959-60	472	12,776	732	13,981	66	4,162	140	4,367	441	15,544	1,337	17,322
1960-61	379	12,941	658	13,977	44	4,611	314	4,969	163	8,574	712	9,450
1961-62	396	13,078	511	13,985	76	3,450	230	3,755	280	12,853	1,678	14,813
1962-63	360	12,436	810	13,606	31	4,839	230	5,099	130	7,282	898	8,311
1963-64	359	12,623	720	13,702	46	4,929	224	5,199	189	15,577	2,370	18,136
1964-65	621	11,453	921	12,995	93	4,378	347	4,818	293	9,208	1,223	10,724
1965-66	571	11,169	1,271	13,012	101	5,119	363	5,583	483	10,138	2,895	13,515
1966-67	504	10,238	1,677	12,419	198	5,465	516	6,179	644	12,881	3,785	17,309
1967-68	148	9,984	2,581	12,713	10	5,664	657	6,331	308	10,096	4,605	15,009
1968-69	388	9,638	2,109	12,135	290	4,419	490	5,200	332	8,923	4,009	13,263
Season (August-July)												
1969-70	606	9,344	2,148	12,098	350	5,283	732	6,365	729	8,033	3,079	11,841
1970-71	604	9,421	1,850	11,875	218	5,143	924	6,285	603	7,689	4,151	12,443
1971-72	660	9,436	1,912	12,008	359	6,704	1,038	8,101	806	10,085	3,975	14,866
1972-73	490	9,257	2,459	12,206	110	8,394	1,381	9,885	1,590	14,957	6,343	22,890
1973-74	515	9,576	2,267	12,358	235	7,762	1,947	9,944	319	10,045	2,888	13,252
1974-75	536	8,797	2,598	11,931	577	8,223	2,211	11,011	1,900	21,042	12,586	35,528
1975-76	1,226	8,098	2,667	11,991	949	7,360	1,526	9,835	1,384	8,948	2,894	13,226
1976-77	994	8,517	3,018	12,529	758	9,955	2,436	13,149	1,780	15,692	7,941	25,413
1977-78	1,202	8,199	3,628	13,029	1,110	7,500	2,772	11,382	3,588	14,523	9,505	27,616
1978-79	837	7,378	3,822	12,037	870	6,650	4,242	11,762	831	6,533	7,949	15,313
1979-80	1,415	7,854	2,846	12,115	1,234	5,886	2,162	9,282	2,729	12,750	4,590	20,069
1980-81	1,662	7,879	3,489	13,030	1,646	5,204	2,924	9,774	5,478	21,825	13,464	40,767
1981-82	1,564	7,262	4,045	12,871	1,707	3,371	2,742	7,820	3,235	14,265	11,867	29,367
1982-83	1,724	7,686	4,222	13,632	2,019	4,294	2,323	8,636	3,120	15,815	7,353	26,288
1983-84	1,223	8,376	3,823	13,422	1,397	4,815	2,659	8,871	2,079	12,052	5,022	19,153
1984-85	1,536	8,325	4,138	13,999	1,840	4,901	2,313	9,054	3,020	14,876	10,112	28,008

[a]Includes shipments to Canada.
[b]Includes small quantities eliminated.
[c]Varying car loadings converted to standard carlots of 1,000 cartons.

Source: Annual reports of the Lemon Administrative Committee.

Appendix Table 8. California-Arizona Lemons: Percentage Distribution of Total District Production to Market Outlets by District, 1955-56 through 1984-85 Seasons

Season	District 1			District 2			District 3		
	Domestic	Export	Processed	Domestic	Export	Processed	Domestic	Export	Processed
year	percent								
1955-56	65.4	2.3	32.3	55.1	13.3	31.6	52.6	0.4	47.0
56-57	70.0	1.0	29.0	46.4	13.0	40.6	53.8	0.8	45.4
57-58	50.2	12.8	37.0	41.9	18.4	39.7	40.4	1.5	58.4
58-59	51.3	2.4	46.3	40.2	10.0	49.8	42.7	4.8	52.5
59-60	48.2	6.7	45.0	39.3	12.8	47.7	33.1	6.3	60.5
1960-61	64.7	7.5	27.8	49.5	17.6	32.8	39.1	18.6	42.3
61-62	52.7	10.1	37.2	44.5	11.7	43.7	21.1	9.5	69.4
62-63	69.1	6.0	25.0	50.7	19.7	29.6	41.8	11.9	46.3
63-64	60.4	7.7	31.8	38.1	14.9	47.0	21.7	6.8	71.5
64-65	61.7	9.2	29.1	45.7	17.5	36.8	37.0	13.9	49.1
65-66	49.4	8.7	41.8	42.3	19.4	38.4	28.1	8.0	63.9
66-67	37.4	14.7	47.8	35.8	19.1	45.1	28.1	8.6	63.3
67-68	31.8	2.1	66.1	38.8	22.0	39.2	32.9	8.4	58.7
68-69	38.4	18.7	32.9	41.9	19.2	38.8	31.9	7.4	60.7
69-70	36.0	20.8	43.3	41.2	23.3	35.5	36.1	12.3	51.7
1970-71	42.5	15.3	42.3	42.3	23.1	34.6	26.7	13.3	59.9
71-72	36.2	19.7	44.2	36.0	25.6	38.5	27.6	15.0	57.4
72-73	22.4	5 0	72.6	28.4	25.7	45.9	24.1	13.6	62.3
73-74	48.2	22.0	29.8	35.0	28.3	36.7	31.9	27.4	40.7
74-75	17.8	19.2	63.1	23.1	21.6	55.3	14.9	12.7	72.4
75-76	34.4	26.7	38.9	33.2	30.2	36.7	37.6	21.5	40.8
76-77	28.1	21.5	50.4	24.9	29.1	45.9	22.5	18.2	59.3
77-78	20.4	18.8	60.8	27.1	24.8	48.1	22.8	17.4	59.8
78-79	33.0	34.3	32.7	35.9	32.3	31.8	23.9	26.5	49.6
79-80	26.3	22.9	50.7	29.6	22.2	48.1	29.7	22.5	47.8
1980-81	18.9	18.7	62.3	22.6	14.9	62.5	17.6	14.7	67.7
81-82	24.0	26.2	49.7	29.2	13.5	57.3	21.7	14.7	63.6
82-83	25.1	29.4	45.5	27.7	15.4	56.9	30.4	16.7	52.9
83-84	26.0	29.7	44.3	33.2	19.1	47.7	33.2	23.1	43.7
84-85	24.0	28.8	47.2	29.6	17.4	53.0	25.0	14.0	61.0

Source: Lemon Administrative Committee and California-Arizona Citrus League

Appendix Table 9. California-Arizona Lemons: Utilization of Total Winter and Summer Production by Market Outlet, 1950-51 through 1982-83 Seasons

	Winter			Summer		
	Domestic Fresh	Export Fresh	Products	Domestic Fresh	Export Fresh	Products
	1000 cars					
1950-51	5.8	0.1	4.0	10.2	0.5	6.4
51-52	5.9	0.3	4.7	10.5	0.6	4.7
52-53	5.6	0.2	3.3	10.0	0.7	5.7
53-54	5.4	0.3	5.9	10.3	1.4	10.1
54-55	5.3	0.9	4.3	10.0	2.1	5.6
55-56	5.7	1.4	4.9	9.2	2.0	3.7
56-57	5.4	0.7	4.0	9.5	3.2	8.7
57-58	5.3	2.6	6.5	8.9	3.4	7.2
58-59	5.3	1.1	10.7	9.4	2.3	7.3
59-60	5.7	2.1	12.8	8.3	2.3	4.6
1960-61	5.4	1.9	3.2	8.6	3.1	6.3
61-62	5.6	2.1	10.4	8.4	1.6	4.4
62-63	5.4	1.0	2.7	8.0	4.1	5.6
63-64	5.5	1.6	9.5	8.3	3.6	8.7
64-65	5.3	1.1	4.0	7.7	3.7	6.7
65-66	5.5	2.3	8.1	7.6	3.3	5.5
66-67	5.3	2.5	9.5	7.2	3.7	7.8
67-68	5.4	2.3	8.4	7.2	4.0	6.4
68-69	5.2	2.5	9.8	6.9	2.7	3.5
69-70	5.3	2.8	7.8	6.8	3.8	4.6
1970-71	5.2	2.7	7.7	6.8	4.2	5.7
71-72	5.3	3.3	8.8	6.7	4.9	6.3
72-73	5.5	4.4	14.1	6.8	5.3	7.8
73-74	5.5	3.8	7.1	6.5	6.5	7.7
74-75	5.3	4.8	23.6	6.5	5.4	10.0
75-76	5.6	3.8	7.2	6.5	7.4	8.2
76-77	5.6	5.5	15.3	7.3	7.5	9.1
77-78	6.0	5.5	19.3	6.9	6.5	8.2
78-79	5.8	6.3	10.8	5.7	4.1	2.8
79-80	5.7	4.7	13.0	6.7	4.6	10.6
1980-81	6.1	5.5	26.7	7.2	4.1	13.7
81-82	6.4	4.5	20.1	6.6	3.1	8.7
82-83	6.4	4.7	15.3	7.3	4.3	10.4

Source: Lemon Administrative Committee and California-Arizona Citrus League

Appendix Table 10. U.S. Per Capita Consumption of Fresh and Processed Lemons

Year	Fresh	Processed[a]
	--------pounds per capita--------	
1955	3.4	.73
56	3.1	.74
57	3.3	.83
58	3.0	.88
59	2.9	1.11
1960	2.9	1.01
61	2.8	.79
62	2.8	.66
63	2.5	.63
64	2.6	.67
65	2.4	.66
66	2.3	.58
67	2.2	.63
68	2.2	.55
69	2.2	.53
1970	2.0	.45
71	2.2	.46
72	1.8	.50
73	1.9	.59
74	2.0	.54
75	1.9	1.16
76	1.9	.60
77	2.1	.50
78	2.1	.81
79	2.0	.61
1980	2.0	.31
81	2.1	.47
82	2.1	.82

[a]Product weight

Source: U.S. Department of Agriculture, Agricultural Marketing Service, California-Arizona Lemons: Compilation of Statistics.

Appendix Table 11. California-Arizona On-Tree Prices for Fresh, Export and Processed Lemons, Current and Constant Dollars, 1950-51 through 1981-82.

	Current Dollars			Constant Dollars[a]		
Year	Fresh	Export	Processed	Fresh	Export	Processed
	----------dollars per carton----------					
1950-51	1.62	0.78	0.11	1.98	0.95	0.13
1951-52	1.89	1.14	0.35	2.07	1.25	0.38
1952-53	1.86	1.62	0.95	2.10	1.83	1.07
1953-54	1.72	1.17	0.21	1.97	1.34	0.24
1954-55	1.58	0.80	0.05	1.80	0.91	0.06
1955-56	1.81	0.85	0.20	2.06	0.97	0.22
1956-57	1.39	0.59	0.07	1.53	0.65	0.08
1957-58	1.34	0.53	0.08	1.44	0.57	0.09
1958-59	1.51	0.45	-0.11	1.60	0.48	-0.11
1959-60	1.52	0.48	-0.16	1.60	0.50	-0.17
1960-61	1.45	0.46	0.04	1.53	0.48	0.04
1961-62	1.45	0.44	0.04	1.53	0.47	0.04
1962-63	2.04	1.33	0.79	2.15	1.40	0.83
1963-64	1.53	0.82	0.44	1.62	0.g7	0.47
1964-65	1.89	0.83	0.23	1.99	0.88	0.24
1965-66	1.98	0.94	0.31	2.05	0.97	0.32
1966-67	2.10	1.07	0.29	2.10	1.07	0.29
1967-68	2.46	1.55	0.39	2.46	1.55	0.39
1968-69	2.93	2.30	0.34	2.86	2.24	0.33
1969-70	2.63	1.96	0.37	2.47	1.84	0.35
1970-71	2.99	2.48	0.47	2.70	2.25	0.43
1971-72	2.94	2.59	0.47	2.58	2.27	0.41
1972-73	3.49	2.66	0.38	2.93	2.24	0.32
1973-74	3.49	2.93	0.22	2.59	2.18	0.16
1974-75	3.53	3.11	-0.21	2.20	1.94	-0.13
1975-76	3.2D	1.64	-0.47	1.83	0.94	-0.27
1976-77	2.90	1.10	-0.48	1.58	0.60	-0.26
1977-78	4.45	2.36	-0.63	2.29	1.22	-0.32
1978-79	7.19	5.20	0.03	3.44	2.48	0.01
1979-80	4.65	3.96	1.04	1.97	1.68	0.44
1980-81	3.69	2.15	-0.77	1.37	0.80	-0.29
1981-82	3.99	3.20	-1.33	1.36	1.09	-0.45

[a]The constant dollar prices are current dollar prices divided by the U.S. Department of Labor, Bureau of Labor Statistics producers' price index for all commodities, 1967-68 = 1.00.

Source: Sunkist Growers, Inc., as presented in public testimony before USDA Lemon Marketing Order Administrative Hearings, 1984.

Appendix Table 12. Projected Average f.o.b. Prices for California-Arizona Lemons Given Constant Fresh Market Allocations Ranging from 2.1 to 2.5 pounds Per Capita, 1984-85 through 1998-99 Marketing Years

Marketing Year	Fresh Market Allocation, lbs./capita					
	Base	2.1	2.2	2.3	2.4	2.5
	Average f.o.b. price, $/carton					
1984-85	6.02	6.02	5.98	5.90	5.77	5.59
1985-86	6.67	6.67	6.65	6.57	6.43	6.25
1986-87	7.25	7.26	7.25	7.18	7.06	6.89
1987-88	7.83	7.84	7.82	7.75	7.64	7.48
1988-89	8.37	8.37	8.35	8.29	8.19	8.04
1989-90	8.87	8.87	8.85	8.80	8.72	8.60
1990-91	9.34	9.34	9.33	9.31	9.25	9.17
1991-92	9.74	9.75	9.76	9.75	9.73	9.69
1992-93	10.02	10.03	10.06	10.08	10.10	10.11
1993-94	9.95	9.98	10.04	10.11	10.19	10.27
1994-95	9.79	9.83	9.93	10.04	10.18	10.34
1995-96	9.58	9.63	9.76	9.92	10.11	10.33
1996-97	9.33	9.40	9.56	9.76	9.99	10.26
1997-98	9.05	9.13	9.32	9.55	9.81	10.12
1998-99	8.87	8.86	9.08	9.34	9.63	9.96

Appendix Table 13. Projected Average Total Revenue Per Acre for California-Arizona Lemons Given Constant Fresh Market Allocations Ranging from 2.1 to 2.5 pounds Per Capita, 1984-85 through 1998-99 Marketing Years

Marketing Year	Fresh Market Allocation, lbs./capita					
	Base	2.1	2.2	2.3	2.4	2.5
	dollars per acre					
1984-85	552	552	544	526	498	460
1985-86	646	647	641	625	597	559
1986-87	720	723	719	705	681	647
1987-88	788	789	784	772	750	718
1988-89	842	843	838	826	807	780
1989-90	883	884	880	871	857	836
1990-91	916	917	916	911	901	886
1991-92	935	936	938	937	933	926
1992-93	929	931	935	939	941	943
1993-94	867	871	880	892	904	918
1994-95	791	798	813	831	852	877
1995-96	712	721	740	764	793	826
1996-97	632	642	666	694	728	767
1997-98	549	561	589	621	658	701
1998-99	472	485	515	550	590	636

Appendix Table 14. Projected Average f.o.b. Prices for California-Arizona Lemons Given Constant Annual Fresh Market Allocations Ranging from 12,000 to 20,000 Carloads, 1984-85 through 1998-99 Marketing Years

Marketing Year	Fresh Market Allocation, carloads[a]					
	Base	12,000	14,000	16,000	18,000	20,000
	Average f.o.b. price, $/carton					
1984-85	6.02	5.73	6.01	5.90	5.39	4.48
1985-86	6.67	6.28	6.65	6.60	6.12	5.24
1986-87	7.25	6.80	7.22	7.24	6.86	6.06
1987-88	7.83	7.41	7.78	7.84	7.55	6.88
1988-89	8.37	8.00	8.31	8.39	8.21	7.69
1989-90	8.87	8.50	8.78	8.90	8.84	8.52
1990-91	9.34	8.94	9.22	9.39	9.45	9.35
1991-92	9.74	9.35	9.59	9.81	10.00	10.18
19q2-93	10.02	9.65	9.83	10.09	10.43	10.91
1993-94	9.95	9.45	9.67	10.02	10.54	11.36
1994-95	9.79	9.15	9.39	9.84	10.53	11.64
1995-96	9.58	8.79	9.06	9.57	10.38	11.68
1996-97	9.33	8.35	8.69	9.26	10.15	11.52
1997-98	9.05	7.80	8.23	8.87	9.80	11.20
1998-99	8.77	7.24	7.78	8.47	9.43	10.81

[a]A carload is 1,000 cartons with a net weight of 38 pounds per carton.

Appendix Table 15. Projected Average Total Revenue Per Acre for California-Arizona Lemons Given Constant Annual Fresh Market Allocations Ranging from 12,000 to 20,000 Carloads, 1984-85 through 1998-99 Marketing

Marketing Year	Fresh Market Allocation, carloads					
	Base	12,000	14,000	16,000	18,000	20,000
	dollars per acre					
1984-85	552	491	551	526	417	223
1985-86	646	566	642	631	533	349
1986-87	721	628	713	718	642	482
1987-88	788	705	778	788	732	602
1988-89	842	772	831	846	811	714
1989-90	883	817	868	890	878	821
1990-91	916	846	895	926	936	919
1991-92	935	867	909	946	979	1,010
1992-93	929	867	898	941	997	1,077
1993-94	866	786	821	878	962	1,092
1994-95	791	692	730	799	906	1,080
1995-96	712	593	635	712	834	1,029
1996-97	632	488	537	621	750	951
1997-98	549	374	435	525	657	855
1998-99	472	263	337	432	563	752

Appendix Table 16. Estimated Changes in Consumer Surplus (ΔCS) Based on Historical Data Under Constant Fresh Market Allocations of 2.1 Pounds Per Capita

Year	ΔCS (Fresh)	ΔCS(Processed)	ΔCS(Total)
	----------million dollars----------		
1962-63	-24.05	1.46	-22.59
1963-64	-27.79	5.20	-22.59
1964-65	-15.38	3.99	-11.39
1965-66	-14.41	4.61	-9.80
1966-67	-4.97	4.84	-0.13
1967-68	-4.69	3.91	-0.78
1968-69	2.44	2.19	4.63
1969-70	3.96	1.26	5.22
1970-71	6.94	0.46	7.40
1971-72	9.03	0.30	9.33
1972-73	7.40	0.56	7.96
1973-74	12.21	0.01	12.22
1974-75	15.98	-1.61	14.37
1975-76	13.72	-1.99	11.73
1976-77	5.11	-4.41	0.70
1977-78	6.58	-5.77	0.81
1978-79	25.35	-3.38	21.97
1979-80	16.40	-8.31	8.09
1980-81	6.10	-18.58	-12.48
1981-82	5.59	-12.39	-6.80
1982-83	4.76	-11.24	-6.48
1983-84	5.42	-8.04	-2.62
Average Annual Change	2.53	-2.13	0.40

Appendix Table 17. Estimated Changes in Consumer Surplus (ΔCS) Based on Historical Data Under Constant Fresh Market Allocations of 2.2 pounds Per Capita

Year	ΔCS (Fresh)	ΔCS (Processed)	ΔCS (Total)
	----------million dollars----------		
1962-63	-17.99	1.00	-16.99
1963-64	-21.50	3.72	-17.78
1964-65	-8.91	2.64	-6.27
1965-66	-7.81	2.90	-4.91
1966-67	1.70	2.57	4.27
1967-68	2.02	1.74	3.76
1968-67	9.18	0.20	9.38
1969-70	10.72	-0.82	9.90
1970-71	13.73	-1.89	11.84
1971-72	15.81	-2.97	12.84
1972-73	15.81	-2.97	12.84
1973-74	19.19	-3.62	15.57
1974-75	22.57	-11.38	11.19
1975-76	20.90	-5.87	15.03
1976-77	12.02	-12.10	-0.08
1977-78	13.63	-13.86	-0.23
1978-79	33.20	-6.00	27.20
1979-80	24.13	-13.62	10.51
1980-81	13.45	-29.38	-15.93
1981-82	13.62	-19.86	-6.24
1982-83	13.31	-17.83	-4.52
1983-84	14.43	-12.11	2.32
Average Annual Change	9.61	-6.43	3.18

Appendix Table 18. Estimated Changes in Consumer Surplus (ΔCS) Based on Historical Data Under Constant Fresh Market Allocations of 2.3 pounds Per Capita

Year	ΔCS (Fresh)	ΔCS (Processed)	ΔCS (Total)
	million dollars		
1962-63	-11.64	0.60	-11.04
1963-64	-14.87	2.38	-12.49
1964-65	-2.11	1.46	-0.65
1965-66	-0.95	1.36	0.41
1966-67	8.56	0.34	8.90
1967-68	8.89	-0.43	8.46
1968-69	16.05	-1.72	14.33
1969-70	17.55	-2.74	14.81
1970-71	20.52	-3.98	16.54
1971-72	22.45	-5.97	16.48
1972-73	20.47	-10.38	10.09
1973-74	25.93	-6.83	19.10
1974-75	28.59	-22.07	6.52
1975-76	27.81	-9.16	18.65
1976-77	18.43	-19.96	-1.53
1977-78	20.17	-22.23	-2.06
1978-79	40.90	-7.69	33.21
1979-80	31.56	-18.64	12.92
1980-81	20.22	-41.03	-20.81
1981-82	21.37	-27.62	-6.25
1982-83	21.69	-24.70	-3.01
1983-84	23.43	-16.11	7.32
Average Annual Change	16.59	-10.69	5.90

Appendix Table 19. Estimated Changes in Consumer Surplus (ΔCS) Based on Historical Data Under Constant Fresh Market Allocations of 2.4 Pounds per Capita

Year	ΔCS (Fresh)	ΔCS (Processed)	ΔCS (Total)
	million dollars		
1962-63	-5.02	0.24	-4.78
1963-64	-7.94	1.13	-6.81
1964-65	4.98	0.39	5.37
1965-66	6.15	-0.09	6.06
1966-67	15.58	-1.86	13.72
1967-68	15.88	-2.53	13.35
1968-69	23.01	-3.39	19.62
1969-70	24.40	-4.19	20.21
1970-71	27.23	-5.33	21.90
1971-72	28.83	-7.87	20.96
1972-73	26.29	-14.58	11.71
1973-74	32.14	-8.05	24.09
1974-75	33.54	-31.49	2.05
1975-76	34.07	-9.80	24.27
1976-77	23.74	-25.50	-1.76
1977-78	25.54	-28.55	-3.01
1978-79	48.04	-6.33	41.71
1979-80	38.07	-21.42	16.65
1980-81	25.46	-51.89	-26.43
1981-82	28.08	-34.23	-6.15
1982-83	29.17	-30.79	-1.62
1983-84	31.81	-19.29	12.52
Average Annual Change	23.14	-13.88	9.26

Appendix Table 20. Estimated Changes in Lemon Industry Total Revenue (f.o.b.) Based on Historical Data Under Constant Fresh Market Allocations Ranging from 2.1 to 2.4 Pounds per Capita

Year	Fresh Market Allocation, lbs./capita 2.1	2.2	2.3	2.4
	----------million dollars----------			
1962-63	12.35	10.90	8.08	3.91
1963-64	15.06	13.75	10.94	6.66
1964-65	5.57	3.72	0.25	-4.83
1965-66	7.25	4.58	0.18	-5.91
1966-67	0.98	-2.66	-8.05	-15.25
1967-68	1.73	-2.71	-8.98	-17.30
1968-69	-3.03	-8.71	-16.52	-26.86
1969-70	-3.51	-10.24	-19.53	-32.06
1970-71	-5.65	-13.73	-24.87	-40.16
1971-72	-8.49	-16.99	-28.94	-46.20
1972-73	-7.54	-14.54	-25.15	-42.50
1973-74	-12.24	-20.80	-33.51	-54.00
1974-75	-16.07	-19.10	-25.68	-41.70
1975-76	-11.89	-19.96	-32.77	-55.33
1976-77	-1.84	-5.47	-13.24	-31.62
1977-78	-2.76	-6.96	-15.65	-35.59
1978-79	-13.95	-22.33	-35.92	-60.20
1979-80	-14.35	-26.72	-46.37	-81.28
1980-81	10.87	11.45	7.08	-9.79
1981-82	8.37	9.25	5.55	-8.78
1982-83	8.38	9.57	6.65	-5.34
1983-84	4.20	4.09	-0.19	-12.62
Average Annual Change	-1.21	-5.62	-13.48	-28.03

Appendix Table 21. Projected Changes in Consumer Surplus (ΔCS) Under Constant Fresh Market Allocations of 2.1 lbs per Capita

Year	ΔCS (Fresh)	ΔCS (Processed)	ΔCS (Total)
	----------million dollars----------		
1984-85	4.83	-0.48	4.35
1985-86	4.94	-0.85	4.09
1986-87	5.07	-1.14	3.93
1987-88	5.19	-1.05	4.14
1988-89	5.33	-0.97	4.36
1989-90	5.46	-0.91	4.55
1990-91	5.59	-0.87	4.72
1991-92	5.73	-0.86	4.87
1992-93	5.gg	+0.90	4.98
1993-94	6.02	-1.02	5.00
1994-95	6.18	-1.18	5.00
1995-96	6.34	-1.33	5.01
1996-97	6.52	-1.46	5.06
1997-98	6.71	-1.57	5.14
1998-99	6.90	-1.63	5.27
Average Annual Change	5.78	-1.08	4.70

Appendix Table 22. Projected Changes in Consumer Surplus (ΔCS) Under Constant Fresh Market Allocatlons of 2.3 lbs. per Capita

Year	ΔCS (Fresh)	ΔCS (Processed)	ΔCS (Total)
	----------million dollars----------		
1984-85	25.30	-2.22	23.08
1985-86	25.90	-3.89	22.01
1986-87	26.48	-5.23	21.25
1987-88	27.07	-4.83	22.24
1988-89	27.70	-4.54	23.16
1989-90	28.33	-4.33	24.00
1990-91	28.98	-4.18	24.80
1991-92	29.65	-4.18	25.47
1992-93	30.35	-4.45	25.90
1993-94	31.03	-5.29	25.74
1994-95	31.76	-6.34	25.42
1995-96	32.57	-7.46	25.11
1996-97	33.45	-8.54	24.91
1997-98	34.39	-9.52	24.87
1998-99	35.41	-10.25	25.16
Average Annual Change	29.89	-5.68	24.21

Appendix Table 23. Projected Changes in Consumer Surplus (ΔCS) Under Constant Fresh Market Allocations of 2.5 lbs. per capita

Year	ΔCS (Fresh)	ΔCS (Processed)	ΔCS (Total)
	----------million dollars----------		
1984-85	47.64	-3.68	43.96
1985-86	48.72	-6.38	42.34
1986-87	49.68	-8.45	41.23
1987-88	50.67	-7.76	42.91
1988-89	51.72	-7.27	44.45
1989-90	52.80	-6.88	45.92
1990-91	53.92	-6.56	47.36
1991-92	55.06	-6.52	48.54
1992-93	56.24	-7.02	49.22
1993-94	57.37	-8.72	48.65
1994-95	58.57	-10.95	47.62
1995-96	59.97	-13.51	46.46
1996-97	61.53	-16.14	45.39
1997-98	63.24	-18.68	44.56
1998-99	65.12	-20.80	44.32
Average Annual Change	55.48	-9.95	45.53

Appendix Table 24. Estimated Changes in Lemon Industry Total Revenue (f.o.b.) Based on Projections with Constant Fresh Market Allocations Ranging from 2.1 to 2.5 pounds Per Capita

Year	Fresh Market Allocation, lbs./capita				
	2.1	2.2	2.3	2.4	2.5
	million dollars				
1984-85	-0.01	-1.64	-5.44	-11.41	-19.53
1985-86	0.23	-1.07	-4.75	-10.79	-19.21
1986-87	0.46	-0.56	-4.19	-10.46	-19.41
19g7-88	0.30	-1.14	-5.32	-12.29	-22.13
1988-89	0.18	-1.58	-6.20	-13.79	-24.47
1989-90	0.23	-1.51	-6.27	-14.18	-25.41
1990-91	0.40	-1.09	-5.74	-13.74	-25.32
1991-92	0.57	-0.67	-5.24	-13.35	-25.30
1992-93	0.79	-0.11	-4.46	-12.56	-24.75
1993-94	1.56	2.11	-0.94	-7.94	-19.32
1994-95	2.48	4.84	3.50	-1.93	-11.97
1995-96	3.55	8.06	8.88	5.58	-2.45
1996-97	4.72	11.67	15.00	14.28	8.84
1997-98	6.05	15.76	21.98	24.27	21.96
1998-99	7.42	19.96	29.18	34.63	35.69
Average Annual Change	1.93	3.54	2.00	-2.91	-11.52

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