An Economic Evaluation of California Avocado Industry Marketing Programs, 1961-1995

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SUMMARY

This report describes an economic study of the California avocado industry, including its economic history and markets, and presents an econometric model of supply, demand, and price. The objective of this study is to determine the effect of California avocado industry advertising and promotion expenditures on the demand and price for California avocados and to estimate the ratio of benefits to costs for marketing programs conducted by the California Avocado Commission.[i] The econometric model used to evaluate the impact of industry advertising and promotion includes components for avocado supply, demand and equilibrium price. Following is a description of study results for each of the major components.

Avocado Supply

The two major determinants of annual avocado production, average yields and bearing acreage, are examined in some detail. Average yields, which are responsible for sharp year-to-year variations in total production, have become increasingly variable over time. While yields demonstrated a rather steady upward trend from 1926 through 1956, there was little, if any, trend evident after 1957. Possible explanations for termination of the upward trend in yields and increased variability include expansion of new acreage on land not ideally suited to avocado production because of climate, soil quality or topography, and reduced water use due to sharp increases in water costs in major production areas.

Avocado acreage changes annually as producers make decisions on whether to plant new trees or remove existing trees. These decisions are hypothesized to be based on expected profits over the bearing life of new trees or the remaining life of existing trees. Proxies for expectations based on recent prices, costs and total returns, which have performed well in other studies, were used to explain plantings, removals and annual adjustments in both bearing acreage and total acreage. Avocado acreage response equations found (1) that plantings increase with increases in recent average returns per acre adjusted for costs, (2) that favorable income tax provisions for development of groves led to increased plantings, and (3) that sharply increased water costs were correlated with reduced plantings from 1990-91 through 1994-95. Removals of avocado trees tended to respond most to the immediate past year's costs and prices. The plantings and removal relationships were combined in an estimated equation for the annual change in bearing acreage which was used to represent annual acreage response for California avocados in the simulation analysis described below.

The Demand for Avocados

California avocado prices and quantities trended upward over the period considered (1962-95). However, in real terms, prices varied substantially around a slightly downward trend. At the same time, gross producer revenues trended upward in both nominal and real terms, indicating that growth in quantity more than offset the decline in real prices. Overall, there has been significant growth in the demand for avocados over time. Factors associated with this growth in demand are examined in some detail using (1) an annual analysis of demand for the period 1962 through 1995, and (2) a monthly analysis of demand for the nine marketing years 1986-87 through 1994-95

Annual Demand: An annual econometric model of the demand for California avocados, with annual average farm level real price per pound specified as the dependent variable, was specified and estimated. The preferred econometric model, which was selected on the basis of statistical tests and economic theory, shows that the quantity of avocados offered on the market is a very important explanatory factor, having a strong, negative impact on price. The estimated price flexibility of demand of -1.33 (at the average values for each of the variables) means that a one-percent increase in quantity supplied will cause a 1.33 percent decrease in price, and a .33 percent reduction in gross revenue, other factors constant. Demand is quite inelastic, as indicated by year-to-year changes in production and total crop revenues. Surprisingly, the quantity of Florida avocados sold was found to have a positive effect on California prices but, statistically, this effect was not significantly different from zero. Avocado imports were found to have a relatively large, and statistically significant, negative impact on California avocado demand and prices. Real per capita disposable income was found to have a large, and statistically significant, positive impact on avocado demand and prices, confirming that avocados are a normal good and that an increase in consumer income leads to a more-than-proportionate increase in demand.

The annual econometric model indicates that advertising and promotion had a positive impact on California avocado demand and prices, and the

point estimate shows a price response of plausible magnitude (the estimated price flexibility is 0.13, indicating that a one percent increase in advertising and promotion expenditures leads to a 0.13 percent increase in price, holding quantity constant). The estimated effect of advertising and promotion, which is not statistically significant at the usual 95 percent level, is significant at the 86 percent level. This lack of precision for the advertising variable may be the result of data problems and other factors. These include mismatches between the California and Florida crop years that we were unable to correct (and probably resulted in the unexpected positive relationship between Florida sales and California prices), the changing year-to-year activities included in the advertising variable, and possible structural changes. A monthly analysis of demand for California avocados was undertaken as a partial solution to limitations evident in the annual analysis.

Monthly Demand: The model of monthly demand for California avocados was patterned after the annual demand model. Average f.o.b. level monthly real price per pound was specified as a function of pounds of avocados shipped from California and Florida, imports, consumer income, CAC marketing expenditures, brand advertising and promotion, prices of related goods, and monthly demand shifters. Initial testing resulted in deleting several variables from the analysis, including the prices of possible related products and brand advertising expenditures by California avocado packers. None was statistically significant (t-ratios were very small) in any of the formulations tested and it was concluded that these variables have had no statistical effect on the monthly demand for all California avocados. The use of monthly data permitted close matching of avocado sales from all sources, avoided potential problems of structural change, and provided the best available data on advertising and promotion expenditures.

Results of estimating the monthly demand for all California avocados were in line with expectations and were a definite improvement over the annual model. Each of the variables had the expected sign (Florida sales had a negative impact on California prices), most were statistically significant, and the magnitude of the estimates was reasonable. Advertising and promotion expenditures had a statistically significant positive effect on the price of (and demand for) California avocados. The monthly and annual price flexibilities of demand with respect to advertising and promotion were almost identical (0.137 for the monthly analysis vs. 0.130 for the annual analysis). Advertising and promotion also had estimated lagged impacts on California avocado prices and demand that extended five months after the month the expenditures were paid. The estimated price flexibility of demand of -1.54 is larger than the annual estimate of -1.33, but the monthly quantity variable includes both California and Florida sales. The demand for California avocados at average prices and quantities is inelastic at both the farm and f.o.b. levels, whether measured on an annual or monthly basis. This means that total industry revenues will be less for a large crop than for a small crop.

Estimated Benefit-Cost Ratios for Advertising

Measurement of benefits and costs for commodity advertising are not as simple and straight-forward as they first appear. Depending on assumptions, there are different measures of benefits, including average and marginal benefits measured in the short run (assuming fixed supply) or in the long run (after adjustment of acreage to price changes). For this study, fixed supply benefits were estimated both annually and monthly. The time horizon also affects the measurement of costs. In the short run, all costs of advertising and promotion are paid by avocado producers. However, in the long run, producer adjustments to the assessments used to fund advertising and promotion act as a tax, which producers are able to partially shift to buyers. Following are the range of benefit-cost ratios estimated in the study.

The annual fixed supply industry returns from CAC advertising and promotion expenditures ranged from a weighted average of \$5.33 to \$6.01 per dollar spent depending on the time period examined and the discount rate used (note that all returns are total returns before the deduction of advertising expenditures). A simple average of the annual fixed supply benefit-cost ratios is equal to 5.25. Short term returns for the most recent nine years (1986-87 through 1994-95 marketing years), based on the monthly analysis and discounted at 3 percent, yields a weighted average return of \$6.35 per dollar spent on advertising and promotion. For the nine-year period of analysis, the monthly marginal and average benefit-cost ratios are equal to 8.92. The marginal benefit-cost ratios were greater than one for all but two months of the period, indicating that the CAC could have profitably increased advertising and promotion during all but two months of the nine-year period.

These returns are eroded over time, however, when the acreage response to higher returns is factored into the analysis. Producers make decisions in response to higher returns that result in expanded acreage, but there is a lag of several years before production increases. Because demand is inelastic, increased production decreases both price and total revenue and production response may partially or totally offset increased demand due to advertising. The annual simulation model was run with actual and zero advertising and promotion expenditures and the annual difference in total industry revenues was compared to advertising and promotion expenditures. CAC marketing program expenditures increased estimated net total industry revenues by $102.8 million over the period of analysis. In other words, estimated net industry total revenues after deduction of advertising and promotion expenditures would have been $102.8 million lower than actually occurred, and the industry would have been smaller, had the CAC not been conducting its advertising and promotion programs. When real costs and returns were discounted at 0 and 3 percent, the overall long-run discounted real returns from advertising and promotion were $1.78 and $1.71 per dollar spent, if producers paid the total costs of the program. After accounting for costs shifted to buyers, we estimated that California avocado producers enjoyed an annual average benefit-cost ratio of 2.84 for the 34-years of the analysis. The long-run weighted average benefit-cost ratios, when costs and returns are discounted at 0 and 3 percent, are 2.48 and 2.26, respectively.

On a month-to-month and year-to-year basis, the industry has realized excellent returns from generic advertising and promotion programs. Over time, however, the supply response resulting from increased returns can erode prices and net returns. As illustrated, avocados tend to exhibit cycles of production and prices; attractive returns from advertising can contribute to these cycles. This is the nature of the short-run versus the long-run returns to advertising when the industry does not control supply and there is ease of entry and exit. Nevertheless, generic avocado advertising and promotion has provided excellent producer returns in both the short run and the long run.

INTRODUCTION

The objective of this study is to determine the effect of California avocado industry advertising and promotion expenditures on the demand and price for California avocados and to estimate the ratio of benefits to costs for marketing programs conducted by the California Avocado Commission. These marketing activities, which were initiated under a California state marketing order program in 1961, continue to be funded by mandatory assessments on all California avocado producers. The report focuses on two questions: (1) the impact of marketing expenditures on the demand and price for California avocados, and (2) whether net revenues to producers resulting from the program have increased enough to offset the program costs. Answering these questions requires specification and development of a detailed econometric model of the California avocado industry that includes components for market demand and supply response over time.

The organization of the report is based on the steps taken to formulate answers to the research questions. The initial step was to assemble a complete and reliable data base for the analysis. Using this data base, we document the changing patterns of avocado acreage, yields, production, and varieties that represent the supply side of the industry, and then estimate a model of industry supply response consisting of expressions for bearing acreage and average yields. The analysis of supply is followed by a description of the demand for avocados that discusses prices and consumption and presents time-series information on important demand shifters, including income, population, and advertising programs. An annual model of avocado demand is then estimated and relevant flexibilities and elasticities of demand are presented. The annual demand model is supplemented with a monthly analysis of demand based on the most recent nine-year period.

The estimated supply and demand relationships are used to simulate the economic benefits and costs of the avocado industry advertising and promotion program. The first step is to use estimated annual avocado prices both with and without advertising to derive net short-run returns to advertising and promotion. Then, the acreage response relationship is used to derive an estimate of long-run returns that accounts for the impacts of producer supply response over time to the price impacts of advertising and promotion.

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The California Avocado Industry

Avocados are an important and high value fruit crop with annual sales revenue ranking well within the top ten California fruit and nut crops. California produces 85 to 95 percent of the annual U.S. avocado crop, with Florida accounting for the remainder. The demand for avocados has grown over time as a result of growing consumer income, increasing population, and industry-sponsored advertising programs, and producers have responded by expanding planted acreage and production. Bearing acreage, for example, remained under 25,000 acres until 1977 and total crop value did not exceed $25 million until the 1972-73 crop year. Bearing acreage totaled 61,254 acres in 1994-95 (down from a peak of 76,307 acres in 1987-88), and, for the most recent 5-year period (1990-91 through 1994-95 crop years), California's annual avocado production and value averaged 345.5 million pounds and $194.4 million, respectively. Around this trend, avocado production and prices vary substantially from year to year as a result of variable yields and inelastic producer-level demand. With inelastic demand, a large crop returns less total revenue to producers than does a small crop, other factors equal (the percentage decrease in price is greater than the percentage increase in quantity). Avocado producers tend to exhibit extrapolative expectations behavior when making crop investment decisions. They respond to recent crop returns, expanding acreage and production when returns have been favorable for several years and decreasing acreage when recent returns have been low.

Acreage Trends

Avocado production in California has a history extending from 1856, when the first avocado tree imported from Nicaragua was planted near Los Angeles. During the 1880s and 1890s, varieties were being imported from Mexico and seedlings were being grown. The beginning of a commercial industry is placed at about 1910; by the 1919-20 crop year there were 280 bearing and

235 non-bearing acres of avocados recorded in California (Appendix Table 1). Since 1920, the California avocado industry has experienced three periods of expansion, with decreases in bearing acreage following each expansion. As shown in Figure 1, bearing acreage of avocados increased steadily from 280 acres in 1919-20 to 13,565 acres in 1946-47. After a brief pause, bearing acreage again began to grow through the 1950s, reaching 21,921 acres in 1964. Increased new plantings from 1968 through the 1970s fueled an expansion in bearing acreage from 20,715 acres in 1974-75 to a peak of 76,307 acres in 1987-88. Lower avocado prices as a result of increased production in the 1980s, limited availability of suitable land, increased urban pressures, high land costs, and high water costs combined to reduce new plantings and bearing acreage after 1987. The most recent estimate, based on an aerial survey conducted during the 1994-95 crop year by the California Avocado Commission (CAC), reports 1994-95 bearing acreage at 61,254 acres. The CAC estimated 1995-96 bearing acreage at 59,577 acres after adjustments to the survey data for forecast additions to bearing acreage and removals.

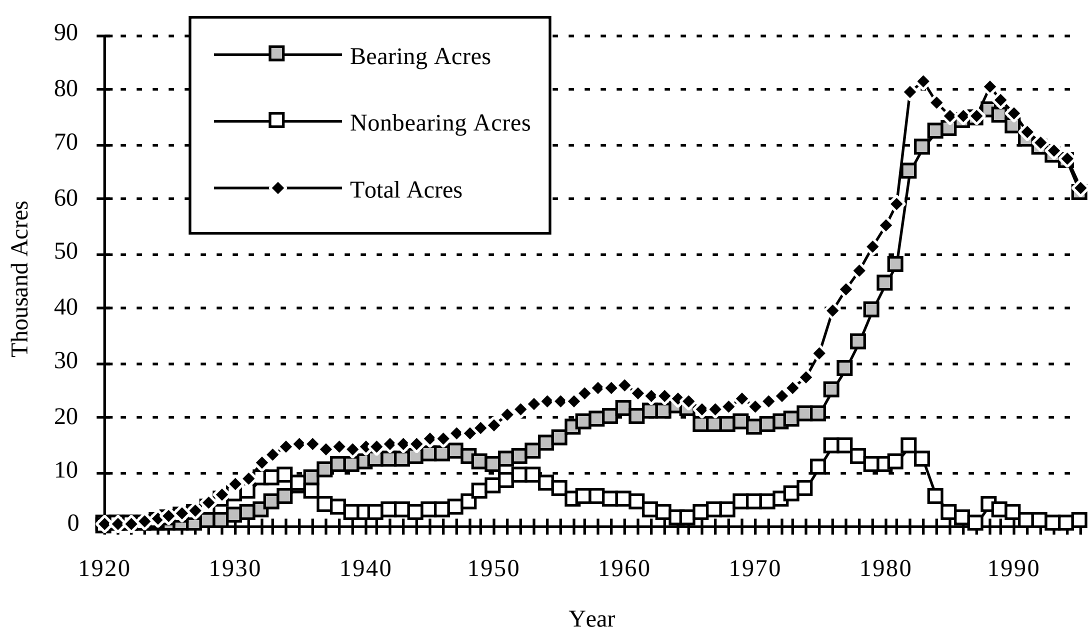

Figure 1. California Avocado Acreage by Category, 1920-1995

Avocado Varieties

More than 20 varieties of avocados have been produced commercially in California since 1950. Of these, four have had recorded acreage of more than 1,000 acres during any crop year and three others have had more than 500 acres. The four varieties with over 1,000 acres include Bacon, Fuerte, Hass, and Zutano while the three with 500 but less than 1,000 acres include Pinkerton, Reed, and Rincon. The relative importance of particular varieties has changed significantly over time, as shown in Table 1. The Fuerte share of total acreage decreased steadily from almost 79 percent in 1950 to just over 10 percent in 1990. It was largely replaced by the Hass variety, which increased from 15.5 percent of total acreage in 1960 to over 71 percent in 1990. In general, the Hass variety has two significant advantages over other varieties; it typically has the highest average yields and the highest average prices per pound. Other varieties, however, have different seasonal patterns of production and may be better suited to particular locations. The Bacon variety's share of total acreage increased from 2.5 percent in 1960 to 11.3 percent in 1980 and then decreased to 9.1 percent in 1990. Zutano acreage had a pattern similar to that of Bacon, increasing from almost 3 percent in 1960 to almost 9 percent in 1980 and then decreasing to 5.5 percent in 1990.

Table 1. Total California Avocado Acreage by Variety, 1950-1990.

Varieties	1950	1955	1960	1965	1970	1975	1980	1985	1990
					Acres				
Bacon	nr	nr	610	811	1,373	4,284	6,692	7,568	6,808
Fuerte	14,897	17,236	15,583	11,865	10,155	10,053	10,747	8,265	7,484
Hass	nr	nr	3,796	4,829	7,484	19,844	33,209	50,622	52,968
Pinkerton	nr	nr	nr	nr	nr	nr	67	501	596
Reed	nr	nr	nr	nr	nr	371	692	734	746
Rincon	nr	nr	680	577	487	320	322	178	142
Zutano	nr	nr	725	576	857	2,833	5,291	5,536	4,145
Other	4,068	5,927	3,029	2,421	2,242	1,869	2,343	1,937	1,553
TOTAL	18,965	23,163	24,423	21,079	22,598	39,574	59,363	75,341	74,442

nr: acreage not reported separately.
Source: California Agricultural Statistics Service, California Fruit and Nut Acreage, annual issues.

There was a change in the varietal composition of production associated with the acreage changes described above. Data on avocado production for three variety categories (Fuerte, Hass and Other) illustrates the shifts occurring. As shown in Figure 2, the Fuerte variety often accounted for the majority of production from 1962 through 1968, but then its share of total production

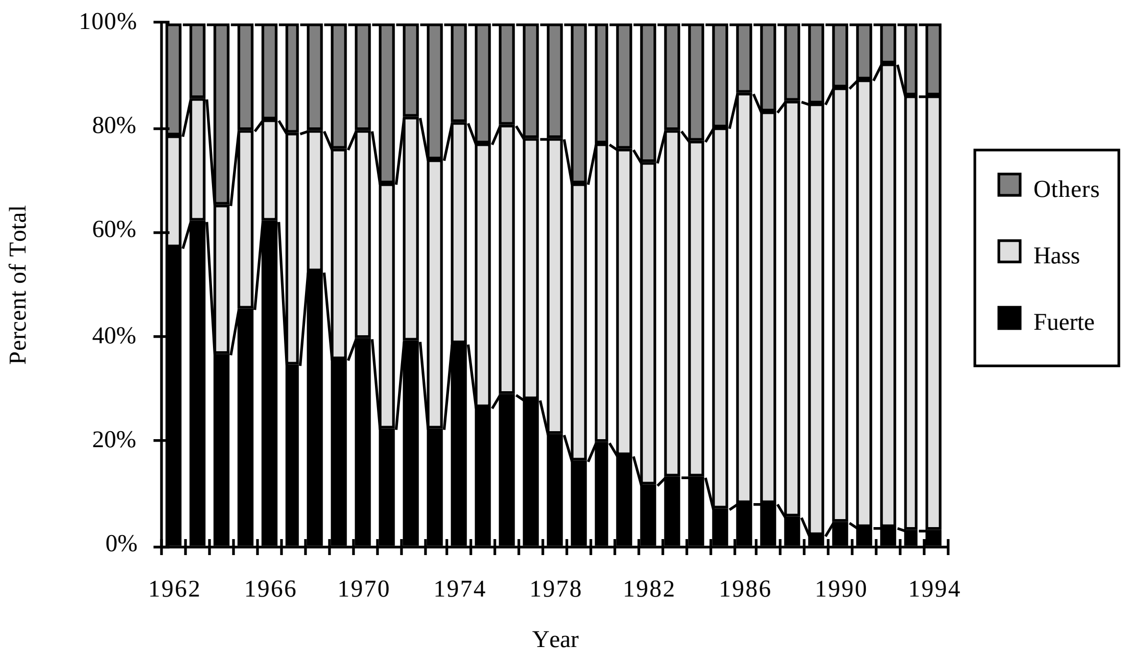

Figure 2. California Avocado Production by Variety, 1962-94

decreased steadily to less than 5 percent in 1994. The Hass variety's share of total production expanded rapidly from just over 21 percent in 1962-63, to over 83 percent in 1994-95, with the increase coming at the expense of the Fuerte and Other variety categories. The Hass variety's increased share of total production was due to its increased share of total acreage and its above-average yields.

<u>Location of Production</u>

Because of weather constraints, California avocado production tends to be concentrated near the coast in Southern California and in micro-climates that have a low incidence of frost.

Commercial production districts used to describe the industry include the North Counties (Santa Barbara, Ventura and San Luis Obispo, the Mid-counties (Los Angeles, Orange, Riverside and San Bernardino), San Diego County, and the San Joaquin Valley Counties (Fresno, Tulare and Kern). As shown in Appendix Table 2, San Diego County accounted for the majority of bearing acreage from 1950 through 1975. As bearing acreage expanded rapidly after 1975, San Diego County's share of bearing acreage dropped to 43 percent in 1980 and then recovered to 49 percent in 1985 and 1990. The 1990 shares of acreage for the other production districts were: North Counties, 34.5 percent; Mid-counties, 14.5 percent, and; San Joaquin Valley Counties, 2.0 percent. The estimated 1995-96 shares of bearing acreage were: San Diego County, 42.3 percent; North Counties, 41.0 percent; Mid-counties, 14.4 percent; and San Joaquin Valley Counties, 1.7 percent (CAC).

Structure of Production

The California avocado industry is composed of a large number of relatively small producers who account for a small proportion of total harvested acreage and a small number of large producers who account for the majority of acreage. The 1992 Census of Agriculture reported that 5,973 farms harvested 67,509 acres of avocados that year, resulting in average harvested acreage of 11.3 acres per farm. The 1987 Census counted 5,920 farms with 79,270 acres of avocados for an average harvested acreage of 13.39 acres. As shown in Table 2, more than half (58.65 percent)

Table 2. California Avocados, Distribution of Farms by Acres Harvested, 1992.

Avocados Acres Harvested	Number of Farms	Total Acres Harvested	Percent of Farms	Percent of Acres	Average Acres/Farm	Cumulative % of Farms	Cumulative % of Acres
.1 to .9	608	298	10.18	0.44	0.49	10.18	0.44
1 to 4.9	2,895	6,536	48.47	9.68	2.26	58.65	10.12
5 to 14.9	1,462	12,046	24.48	17.84	8.24	83.12	27.97
15 to 24.9	473	8,774	7.92	13.00	18.55	91.04	40.96
25 to 49.9	320	10,933	5.36	16.19	34.17	96.40	57.16
50 to 99.9	119	7,943	1.99	11.77	66.75	98.39	68.92
100 or more	96	20,979	1.61	31.08	218.53	100.00	100.00
Total	5,973	67,509	100.00	100.00	11.30		

Source: U.S. Department of Commerce. 1992 Census of Agriculture.

of the 1992 farms harvested fewer than 5 acres of avocados and these farms accounted for only 10 percent of total harvested acres. At the other end of the distribution, 215 farms (3.6 percent) with more than 50 acres of avocados accounted for 42.8 percent of total acreage. The distribution of acreage between large and small avocado producers is similar to many other California tree crops.

Asset Values

The aggregate value of land and trees devoted to California avocado production is relatively high, even for a perennial fruit crop. Several factors are at work, including the high value of the crop, high land values, and high development costs. The average per acre revenues from avocado production are typically high in comparison to many other crops; the land is expensive because climate requirements for avocado production are ideal for many other crops, as well as for people; and budgeted costs for establishment of a new avocado planting have recently been estimated at over $15,000 per acre (Livingston, et al., 1993). With budgeted land costs of $15,000 to $16,500 per acre, total costs to establish a new avocado grove were over $30,000 per acre. A recent survey of California land values estimated 1996 San Diego County avocado grove values ranging from $5,000 to $15,000 per acre (down from a range of $10-17,000 in 1993), Ventura County avocado grove values ranging from $12,000 to $25,000, and Santa Barbara County grove values ranging from $13,000 to $35,000 per acre[1]. If one uses a value of $20,000 per acre for groves in Ventura, Santa Barbara, San Luis Obispo, Orange and Los Angeles Counties and a value of $15,000 per acre for the remaining bearing acreage (San Diego County, Riverside County, San Joaquin Valley and other), a conservative estimate of the value of California's 1994-95 bearing acreage of avocados (61,254 acres) totals over $1 billion.

Avocado Supply

The total supply of California avocados during a given marketing season is the product of bearing acres and average yield per acre. Most of the year-to-year variability of total avocado production is due to the variability of average yields. Bearing acreage tends to change relatively

[1] These values are from California Chapter of the American Society of Farm Managers and Rural Appraisers, Trends in Agricultural Land and Lease Values, Spring Ag Outlook Forum, March 20, 1996, pp. 14, 16.

slowly from year to year as a result of planting decisions made several years earlier and current removal decisions. Average yields, on the other hand, demonstrate large year-to-year variability as a result of weather and other factors, including alternate bearing tendencies of tree crops. In this section of the report we discuss factors associated with varying annual yields, and examine trends in average yields. We then examine factors associated with bearing acreage adjustments over time, including the effects of crop returns on plantings and removals.

Average Avocado Yields

Average annual yields for tree crops are influenced by a number of factors, including weather conditions and alternate bearing tendencies. Over time, the age distribution of trees, the introduction of new varieties or cultural practices, and the availability of water will also affect average yields. There is a lag of several years from the time when a tree is planted until it begins to produce commercial amounts of fruit or nuts (under California conditions the lag is three to five years for avocados, depending on variety), yields increase as trees mature, then remain high for an extended period of maturity, and finally decrease as the trees become old or diseased. Recent budgets use a projected tree life of 40 years.

A 70-year data series on average avocado yields has been assembled from publications of the California Crop and Livestock Reporting Service and its successor agency, the California Agricultural Statistics Service (Appendix Table 3). The pattern of average yields for the 1925-26 through the 1994-95 crop years is shown in Figure 3. Several interesting and important observations on average yields are evident in these data. First, while there has been a definite upward trend in yields over the entire period, there is no clear trend evident in the most recent half of the period (1960 forward). Second, the year-to-year variability of average yields around the trend appears to have increased substantially over time. This pattern is consistent with yields varying by a constant percentage of an increasing average rather than by a constant absolute amount. This percentage variation is verified by plotting the natural logarithm of average annual yields against time. The variability of the logarithm of yields appears relatively constant over the 70 year period. We will specify and estimate alternative average yield equations to quantitatively describe and partially explain yields over time.

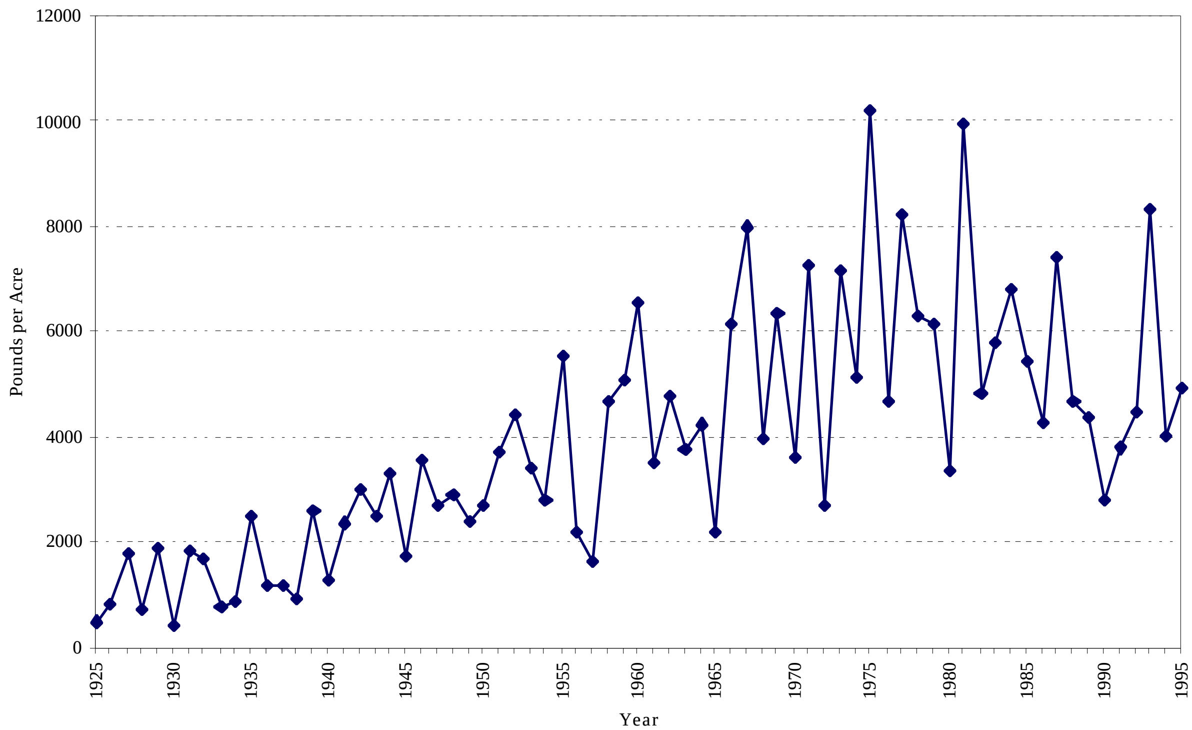

Figure 3. Average Annual Yields for California Avocados, 1925-95

In general terms, we expect average annual avocado yields to be a function of alternate bearing, the age distribution of trees, weather conditions, varieties, and technology. Selection of the appropriate measures for these general variables is both important and difficult. For example, there are several different approaches that could be used to model alternate bearing. We follow the lead of Alston, et al. (1995, p. 9-10) and specify first-and second-order autoregressive schemes to represent alternate bearing. Several other variables are difficult to quantify accurately. Problems arise with measuring the age distribution of trees, since available acreage statistics do not provide a consistent basis for deriving data series for mature and old trees. Differences in yields by variety are best isolated by estimating separate yield equations for each variety but availability of acreage and production data by variety are restricted. While it is clear that weather affects yields, it is difficult to assemble meaningful annual data on rainfall, temperature and humidity that help to explain the annual variation in yields.

Given the data available, a model including the effects of alternate bearing and trends in average annual yields over time was estimated for the period 1927 through 1995. The general form used for the yield equation is:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 (Y_{t-1} - Y_{t-2}) + \alpha_3 T_t \qquad (1)$$

where, Y_t is yield in pounds per bearing acre in year t, Y_{t-1} and Y_{t-2} are yield per acre lagged one and two years, respectively, and T_t is an annual time trend, with 1927=1, ..., 1995=70. The estimated coefficients for the average yield equation are shown in the first column of Table 3, with t-statistics in parentheses below each coefficient.

Results of estimating the average yield equation over the entire period of 69 years are consistent with the scatter diagram of yields over time shown in Figure 3. There is a positive and

Table 3. Estimated Annual Average Yield Equations for California Avocados.

Explanatory Variable	Dependent Variable		
	Y_t	Y_t	Y_t
	--------------------estimated coefficients -----------------		
Constant	1125.34	992.15	4600.41
	(2.71)	(2.90)	(3.60)
Y_{t-1}	0.20	-0.57	0.04
	(1.08)	(-1.66)	(0.15)
Y_{t-1} -Y_{t-2}	-0.27	0.09	-0.18
	(-2.14)	(0.38)	(-1.07)
T	57.48	158.76	19.96
	(3.40)	(4.10)	(0.74)
R^2	0.53	0.63	0.08
Observation Period	1927-95	1927-56	1957-95

Numbers in parentheses are t statistics.

significant trend in yields with average yields increasing 57.48 pounds per year. Evidence of alternate bearing is limited, however, since the estimated coefficient on one-year lagged yields is not significantly different from zero and has an unexpected positive sign. Diagnostic tests performed on the yield equation reveal the presence of heteroskedasticity and structural change, problems which must be corrected if one is to be confident of estimated relationships. The Chow test indicates that a statistically significant change in the structure of yields occurred between 1956 and 1957. Thus, it is not correct to assume that average yield coefficients were equal over the entire period and separate equations must be estimated for the two periods 1927-1956 and 1957-1995.[2]

The yield equation estimated for the first part of the period (1927-1956, shown in the middle column of Table 3) has a very significant trend in average yields with an annual increase of 158.76 pounds. While the coefficients on lagged yields have plausible signs, neither is significantly different from zero. Thus, there is not strong evidence of alternate bearing during the first portion of the period of analysis.

The analysis of factors associated with average yields during the second portion of the period (1957-95, shown in the third column of Table 3) is not at all definitive, with the variables included explaining only 8 percent of the annual variation in average yields. None of the estimated coefficients was significantly different from zero. Thus, we conclude that there is no recent trend in average avocado yields (either positive or negative), nor is there statistical evidence of alternate bearing.

There is not an obvious explanation for the increased variability of average avocado yields over time or for termination of the upward trend observed for many years. The average yields for most crops have, in fact, continued to increase over time as improved and new varieties have been introduced, as management techniques have improved, and as trees reach maturity. One would have expected average avocado yields to increase during the 1970s and 1980s as sharply increased new acreage matured, and as the mix of trees changed to the higher yielding Hass variety. Three factors

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[2] Estimation of the yield equations in logarithms will solve the problem of heteroskedasticity but the strucutural change requires separate equations. Note that the yield equations estimated in logarithms, but without the difference in lagged yields (Y_{t-1} - Y_{t-2}) which were negative for some years, had results very similar to those reported in Table 3. The results are presented in levels for ease of interpretation.

could have contributed to termination of the upward trend and increased variability of average yields. First, and most important, a significant portion of the new acreage planted during the 1975-85 decade may have been less well-suited to avocado production (or even marginal) than the core acreage because of climate, soil quality, or topography. Second, the growth in average yields would be expected to level off as trees matured and the age distribution of trees changed significantly over time. While a consistent series of acreage by age is not available for the total period of analysis, the proportion of trees over 11 years of age increased from about 31 percent in 1982 to 89 percent in 1992. And third, sharp increases in water costs in major production areas may have resulted in reduced water use and this may be associated with reduced yields in many groves.[3]

Average yields by variety

Average avocados yields tend to vary by variety. A set of data on bearing acreage and total production for three variety categories (Fuerte, Hass and all others) permits a limited comparison of average yields by variety for the period from 1962 through 1992. Over this period, the average annual yields were: Hass, 6,675 pounds per acre; Fuerte, 4,281 pounds per acre; and all other varieties, 5,111 pounds per acre. There were significant differences in shares of acreage and total production because of differences in average yields. In 1992, for example, the Hass variety accounted for 72 percent of bearing acreage and 89 percent of total production, while the Fuerte variety had 10 percent of bearing acreage and only 3 percent of total production. All other varieties had 18 percent of bearing acreage and 8 percent of total production in 1992.

There are varietal differences in the year-to-year variability of average yields. As shown in Figure 4, Hass avocado acreage has experienced the highest average yields, exceeding 10,000 pounds per acre four times during the 1962-92 period, while Fuerte has had the lowest yields, dropping below 2,000 pounds per acre during five different crop years. The range between high and low yields during the period was highest for the Fuerte variety at 8,806 pounds per acre (from a minimum of 430 to a maximum of 8,806 pounds per acre). During the 1962-92 period, the

[3] One would not usually expect growers to limit the use of an input such as water on a high-value crop such as avocadoes. Note, however, that water costs for some growers using municipal water supplies increased to over $400 per acre foot and annual water applications have ranged to over four acre-feet per acre. Over the last decade, average total revenue per acre has ranged from $1256 to $3757.

coefficients of variation (the standard deviation divided by the mean) for annual yields by variety were: Fuerte, .5625; Hass, .3476; and Others, .3283. It is not surprising that analysis of factors

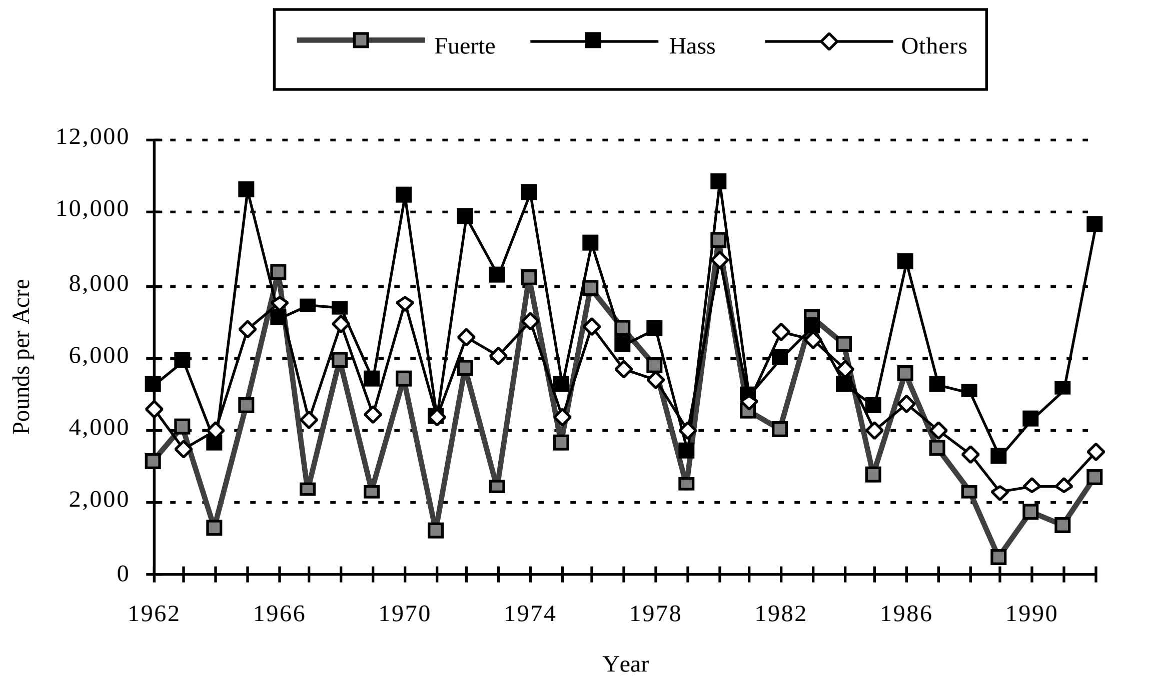

Figure 4. Average Annual Avocado Yields by Variety, 1962-92

associated with annual changes in yields by variety were similar to the analysis for all avocados for the 1957-95 period. That is, there is limited evidence of any trend in average yields or of alternate bearing.

Acreage Response

Actual and potential avocado producers make decisions each year concerning whether or not to plant new trees and, if the decision is positive, the number of acres to plant. Existing producers also make decisions on the removal of trees. These decisions, which are based on the expected profitability of avocado production versus alternative investments, result in net annual changes (either positive or negative) in avocado acreage. If new plantings during the year exceed removals, total acreage expands; if new plantings are exceeded by removals, total acreage decreases. Since avocado trees require 3 to 5 years after planting to reach commercial production, positive net increases in acreage will not have significant effects on production for several years. These lags and the implications for the formation of expectations that affect the investment decision are very important in modeling both acreage and production response.

The theoretical framework for models of perennial crop producer supply response has been developed and tested for several crops. Included are studies by French and Matthews, Rae and Carman, Baritelle and Price, Bushnell and King, Thor and Jesse, French and Bressler, Minami, French and King, Alston, Freebairn and Quilkey, Alston, et al. (1995), and Carman and Green, among others.[4] Data quality and availability are important modeling constraints that often dictate the nature of the supply relationships estimated for perennial crops. Each of the avocado acreage data series are examined in terms of strengths and possible weaknesses.

The bearing acreage of avocados in year t is the result of past plantings and removals decisions, as noted above. This relationship can be expressed as:

$$BA_t = BA_{t-1} + NP_{t-k} - R_{t-1} \qquad (2)$$

where BA is bearing acreage, the subscript t or time designates the year, k is a lag of k years required from the time when a tree is planted until it reaches bearing age, NP is new plantings (acres) and R is acres removed. Thus, explanation of the bearing acreage in any year depends on explaining planting and removal behavior lagged an appropriate number of years.

New Plantings

The acreage of new avocado trees planted during any year is based on the expected profitability of avocado production over the bearing life of the trees. Since expectations cannot be observed, estimation of a plantings equation requires specification of a set of observable variables related to expectations. The studies referenced above typically employed a moving average of recent past values of returns as a proxy for expectations of future values of returns based on the observation that producer expectations are often formed from recent experience. Some studies used gross returns, others used net returns. Some returns were expressed in current dollars while others were in real terms.

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[4] Alston, et al. (1995) include a summary of the main perennial crop supply response studies in the literature (pp. 16-22).

Income tax laws related to the tax treatment of development expenses, effective during a portion of the study period, affected the after-tax costs of development and are expected to have had an impact on planting decisions. Income tax rules requiring capitalization of development expenses for citrus and almonds, effective in 1969 and 1970, resulted in a discrete shift of investor interest from citrus and almonds to other crops, including avocados, grapes and walnuts (Carman). Then, tax law changes in 1976, that restricted write-offs of orchard development costs for limited partnerships, slowed syndication activity in all orchard crops. A discrete change in tax laws, such as occurred, is likely to change the parameters linking production response to prices and other variables in a one-shot fashion. This can be modeled by the use of a dummy variable that has a value of one when the law stimulates investment in new orchards (between 1971 and 1976) and zero otherwise. Such a dummy variable can be used to allow for a change in the intercept, or in any of the model's parameters.

While one would expect other factors, such as the expected profitability of alternative crops, to affect the planting decision, attempts to include such factors in estimated relationships have met with limited success.

Using previous work as a guide, the plantings equation for avocados was specified as:

$$NP_t = f(TRA_{t-1,m}, TAX, TA_t) \quad (3)$$

where NP_t is acres of avocados planted in year t, TRA is a lagged moving average of farm-level total revenue per acre for avocados deflated by the index of prices paid by farmers for all commodities, services, interest, taxes and wage rates, (with the length of the moving average, m, to be based on the data), TAX is a zero-one variable to capture the impact of income tax law changes and TA_t is total avocado acreage in year t. Given that profit expectations are based on recent experience, new plantings are expected to have increased as average returns increased. In addition, the level of plantings required to maintain a given level of acreage increases as acreage increases.

The California Agricultural Statistics Service published annual estimates of the acreage of new avocado trees planted through 1992. These data were based on a combination of detailed acreage surveys from a few counties each year and estimates provided by Agricultural Commissioners in the others. Close examination of these data reveal that plantings reported in year t are typically much smaller than reported acres of k-year old trees standing in a subsequent year t + k (i.e., that were planted in year t). The delayed appearance in the data of plantings made in year t for a number of years is partially explained by the data collection process. Counties would conduct a detailed survey only once each 5 to 8 years and would estimate acreage for the other years. It appears that the estimates in intercensal years were based on known new plantings, and there were always additional plantings that were only discovered by detailed surveys. This is illustrated in Appendix Table 4. The first column of acreage figures are the new plantings originally reported and estimated in year t. Reading across a given row shows the acreage that was planted in year t and reported standing from 1 to 8 years later. For example, reading across the row for 1980, we see that 3,636 acres of avocados were reported as planted in 1980. In 1981, 4,556 acres of avocados were reported as planted in 1980 and in 1982 the reported acres standing that were planted in 1980 increased to a maximum of 4,629. Acres reported as planted in 1980 remain in a range of 4,026 to 4,198 acres thereafter. The bold-faced entries in the table are the maximum acres reported as being planted in each year (t) and they typically occur several years after the planting date.

Removals

Avocado trees may be removed for various reasons including low yields due to disease or age, because of persistent low returns, or to develop the land for other uses. Lacking detailed data on age of trees, incidence of disease, or the effect of urbanization, empirical estimates of removal relationships for perennial crops have met with limited success. A noteworthy exception was the cling peach study by Minami, French and King, which had detailed acreage data by age category. Faced with data problems, which were also present for avocados, most studies have experienced difficulty in isolating variables that are highly related to removals, and have used a constant percentage of acres or a measure of profitability at the time the removal decision was made. This study specified the removals function as:

$$R_t = f(TRA_{t-1,m}, BA_t) \qquad (4)$$

where the variables are as defined above. One expects removals to increase when returns are low and to decrease when returns are favorable. Removals are also expected to vary directly with bearing acreage. Since the data required to create variables to measure other factors such as urbanization, disease, and tree age were not available, their impacts will be included in the constant and error terms.

Removals of avocado trees are not typically reported; construction of a removal series is based on data that are reported. One can work from the total acreage relationship to derive estimates of removals. Begin by specifying year-to-year changes in total avocado acreage (TA) as a function of plantings and removals, as was done in equation (2) with bearing acreage:

$$TA_t = TA_{t-1} + NP_{t-1} - R_{t-1} \qquad (5)$$

Solving for removals, we have:

$$R_{t-1} = TA_{t-1} - TA_t + NP_{t-1} \qquad (6)$$

In terms of the acreage series reported, total acres (TA_t) in year t is the sum of bearing and nonbearing acres in year t, and nonbearing acres are the sum of new plantings for k years, where k is the number of years after planting for avocados to be classified as bearing. Since new plantings may not be counted for several years, as noted above, and the data on nonbearing acres are not usually updated, the direct estimation of removals is subject to substantial error.

The estimation of removals is illustrated in Appendix Table 5, using the acreage figures reported in the annual reports of the California Avocado Commission (CAC). The bearing and nonbearing acres for each year are added to obtain total acres. The estimate of removals is calculated according to equation (6), using maximum plantings reported in year t (Appendix Table 4). A problem with the data series used to derive removals is readily apparent; removals are negative in three years, 1968 (-629 acres), 1981 (-15,614 acres) and 1987 (-4,495 acres). Large negative removals in 1981 are apparently due to discovery of previously uncounted acreage in the detailed acreage surveys for San Diego, Santa Barbara and Ventura Counties. The CAC conducted an aerial survey in 1987-88 that resulted in a sharp increase in reported nonbearing acreage.

The problem of negative removals (and the discovery of new plantings over time) is an indication of other problems with the reported acreage series. Most importantly, few of the series were revised as new information became available for previous years. CASS did provide revised estimates for the previous year's bearing and nonbearing acreage but these were not incorporated in the past yield or production data. Close examination of the revised estimates indicates that most revisions were small and the revised series did not solve the problem of negative removals. Thus, one must allow for the newly discovered acreage in each of the three years 1968, 1981 and 1987 when making empirical estimates of acreage response. One can work with the plantings series derived in Appendix Table 4 to derive revised estimates of bearing and nonbearing acreage series but the accuracy of any revisions is unknown[5].

Empirical Estimates of Acreage Response

Several alternative approaches can be used to estimate acreage response, with the choice usually based on the availability and quality of data and the purpose of the estimates. Probably the most direct approach is to estimate the annual change in total acreage, which is the difference between plantings and removals or net investment in acreage of the crop. If reliable data are available on annual plantings and removals, a separate equation for each can be estimated and these can be combined to calculate annual changes in acreage. If the purpose of the acreage response analysis is to estimate the annual production of the crop, one can estimate a single equation for the net change in bearing acreage that includes lagged values of the variables affecting planting and removals. This equation is used to calculate bearing acreage, which when multiplied by average yield, gives total production. One can also estimate separate equations for plantings and removals and use a running sum of the most recent plantings to estimate nonbearing acreage, or a lagged value of planting to account for the usual period required to reach bearing age. The alternative approaches used to estimate models of supply response for avocados in this study include: (1) separate equations for

[5] Carman and Green used this approach but their simulations of bearing acreage were consistently above revised bearing acreage during the 1970s.

plantings and removals, (2) the annual change in total acreage, or net investment, and (3) the annual change in bearing acreage.

Planting and Removal Equations

The new plantings relationship specified above is used as a basis for estimating an avocado plantings equation using a linear specification. While the variables included in the equation explain a reasonable percentage of the variation in annual plantings, the Durbin-Watson statistic indicates that there is positive serial correlation. This could be due to use of an incorrect functional form and/or omitted variables, but is most likely due to measurement problems in the plantings data with the most recent observations being understated. The new plantings equation, estimated from data for the period 1951-52 through 1992-93, is shown in the first column of Table 4. NP_t , acres of avocados planted in year t, is the dependent variable. The explanatory variables include $TRA_{t-1,4}$ (a four-year average of total revenue per acre deflated by the index of prices paid by farmers for all production items (1977=1.00) and lagged one year), DWater (a dummy variable to capture the impact of sharply increased water costs with a value of one from 1990-91 through 1994-95 and zero for other years), Dtax (a dummy variable to capture the effect of income tax incentives available from 1970-71 through 1975-76), and the t-ratios are in parentheses. Note that the 4-year average of deflated total revenue per acre lagged one year, which was used as the proxy for profit expectations, yielded better statistical results than did other averages of total revenue or prices. Each of the estimated coefficients has the expected sign and, except for the coefficient on the tax variable, all are statistically significant at the traditional 95 percent level. The tax coefficient is not significantly different from zero.

While removals may be related to several factors, only a proxy variable for profit expectations and bearing acreage were included in the equation estimated. There was also the problem of what to do with the negative removal observations. Possible alternatives were to: (1) change each negative value to zero, (2) revise the acreage series to remove the problem, or (3) remove their effect with a dummy variable for each year they occurred. The dummy variable approach was used. The estimated equation for removals is in the second column of Table 4. The number of

Table 4. Estimated Annual Acreage Response Equations for California Avocados.

Explanatory Variables	Dependent Variable			
	NP_t	R_t	ΔTA_t	ΔBA_t
	estimated coefficients			
Constant	-4,696.21 (-7.37)	-552.17 (-0.67)	-4,545.31 (-5.39)	-3,640.848 (-5.30)
$TRA_{t-1,4}$	3.90 (10.59)	0.67 (1.54)	3.42 (6.07)	
$TRA_{t-5,4}$				2.885 (5.95)
PPI_{t-1}				-7.169 (-1.69)
PR_{t-1}				28.206 (2.65)
D81		-17,867.74 (-13.70)	18,432.14 (12.88)	12,246.90 (9.90)
D87		-7,045.33 (-5.27)	6,257.44 (4.37)	
DWater	-2,674.06 (-4.96)		-2,934.13 (-4.75)	-2,544.724 (-3.35)
$DTax_t$	1,097.48 (1.84)		1,053.61 (1.17)	
$DTax_{t-5}$				1,753.65 (2.89)
TA_t	0.024 (3.52)			
BA_t		0.033 (3.79)		
R^2	0.85	0.84	0.89	0.92
D.W.	0.69	1.99	1.87	2.12
Observation Period	1950-93	1950-95	1950-95	1952-95

Numbers in parentheses are t statistics.

acres removed in year t (R_t) is the dependent variable. Independent variables in the removals equation included the proxy variable for expected profits (a four-year average of total revenue per acre deflated by the index of prices paid by farmers for all production items (1977=1.00) lagged one year ($TRA_{t-1,4}$), D81 and D87 (the dummy variables for negative removals in 1981 and 1987), and bearing acreage (BA_t). The coefficients on the dummy variables and bearing acreage each have the expected sign and are statistically significant at the 99 percent level. The estimated coefficient for deflated total revenue per acre has an unexpected positive sign but it is not significantly different from zero (the t-statistics are in parentheses) at the traditional 95 percent level. The variables included in the equation explain 84 percent of the variation in removals and there is no evidence of autocorrelation. Variables for income taxes, high water costs, and negative removals in 1968 were not significant and were not included in the final equation.

Change in Total Acres

The change in total avocado acreage from year t-1 to year t is the difference between plantings and removals, or net investment. The estimated equation for net investment (ΔTA_t), in the third column of Table 4, includes the independent variables used to estimate plantings and removals. Each of the coefficients has the expected sign and all are significant except for the dummy variable for tax law changes affecting development costs.

Change in Bearing Acres

The bearing acreage data series is the most important series in working with supply response and it is also probably the most accurate of the acreage series available. Rather than estimate bearing acreage directly from equation (2), lagged bearing acreage is subtracted from both sides and the annual change in bearing acreage ($\Delta BA_t = BA_t - BA_{t-1}$) is estimated. The formulation is similar to the net investment equation estimated above but with extensive lags on new plantings because of the time required to reach bearing age. The time to bring an avocado tree into bearing varies from three to five years, but for the Bacon, Hass and Zutano varieties that account for over 85 percent of acreage, three years is typical. Since it is not unusual to have another year delay between the planting decision and actual planting as a result of land preparation and acquisition of nursery stock, the usual lag between the decision to plant an avocado tree and the time it reaches bearing age is probably at least four years (k= 4). Lags of 4, 5 and 6 years for the variables associated with plantings were examined; the 5-year lag yielded the best statistical results.

The estimated change in bearing acreage equation is shown in the fourth column of Table 4. Each of the coefficients has the expected sign and all except the coefficient for the one-year lagged cost index were statistically significant at the 95 percent level or greater. The proxy variable for expected profits affecting planting is a four-year average of total revenue per acre deflated by the index of prices paid by farmers for all production items (1977=1.00) lagged five years ($TRA_{t-5,4}$). The four year average yielded better statistical results than did either a three or five year average. The five year lag was also preferred to either four or six years, based on standard statistical measures. The proxy variables used for expected profits in the removals equation were average prices and the cost index, each lagged one year[6]. It is not unusual in empirical work to find that removals respond to more recent economic factors than do plantings, even though one would expect profit expectations affecting plantings and removals to have similar time horizons. The 1987 dummy variable was not significant and was deleted. Examination of the acreage data shows that the adjustment that occurred in 1987 impacted nonbearing and total acreage much more than it did bearing acreage. Income tax laws had a significant impact on plantings during the six year period 1970-71 through 1975-76; the DTax variable had a value of one for each of those six years and zero otherwise. The estimated coefficient on the DTax variable indicates that the shift of investor interest (due to restrictions on citrus and almonds) increased total avocado plantings by almost 1753 acres each year relative to the "no tax law" period. The impact of taxes on change in bearing acreage was lagged five years because of the delays between planting and bearing noted above. The estimated coefficient on the dummy variable for the increase in water prices indicates that bearing acreage decreased almost 2545 acres each year during the five years from 1990-91 through 1994-95. Further decreases of this magnitude are unlikely; the industry has worked closely with local

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[6] Lagged price and the cost index were used after the four-year average of real total revenues lagged one year was not statistically different from zero.

water agencies to receive some relief, and the most vulnerable acreage has already been removed. Unexplained variation in the change in bearing acreage equation is relatively small.

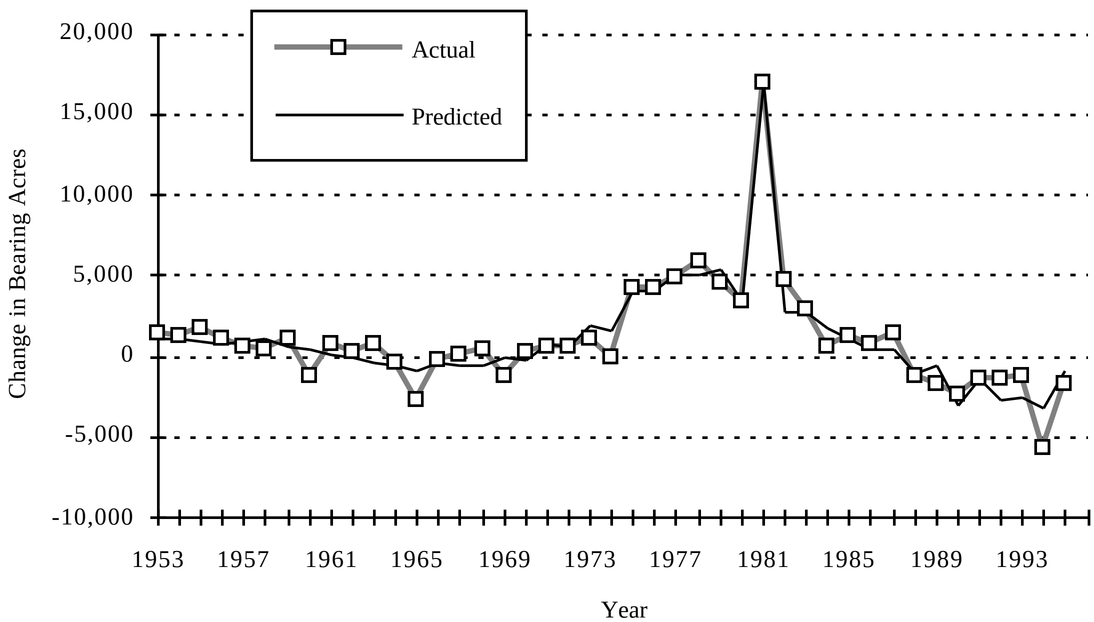

Figure 5. Annual Change in Bearing Acreage of California Avocados, Actual versus Predicted, 1953-95

The estimated change in bearing acreage equation has estimated coefficients that are consistent with expectations, it explains a high proportion of the annual variation in bearing acreage, and it is also the easiest to work with in simulating acreage and supply response to various policies and programs. As shown in Figure 5, the equation does a reasonable job of predicting annual changes in bearing acreage, given values for each of the independent variables. When an initial value for bearing acreage is entered, the change in bearing acreage equation also provides estimates that track total bearing acreage quite well[7]. The comparison of actual and predicted bearing acreage in Figure 6 shows a tendency for the model to slightly over-estimate bearing acreage during the early years when acreage was comparatively stable and to under-estimate the total when acreage was expanding

[7] The estimated change in bearing acreage for each year t is added to the estimated bearing acreage for the previous year, t-1, to yield a cumulative summation of bearing acreage.

rapidly. In overall terms, however, the estimated values are quite close to actual values during the 44 years analyzed.

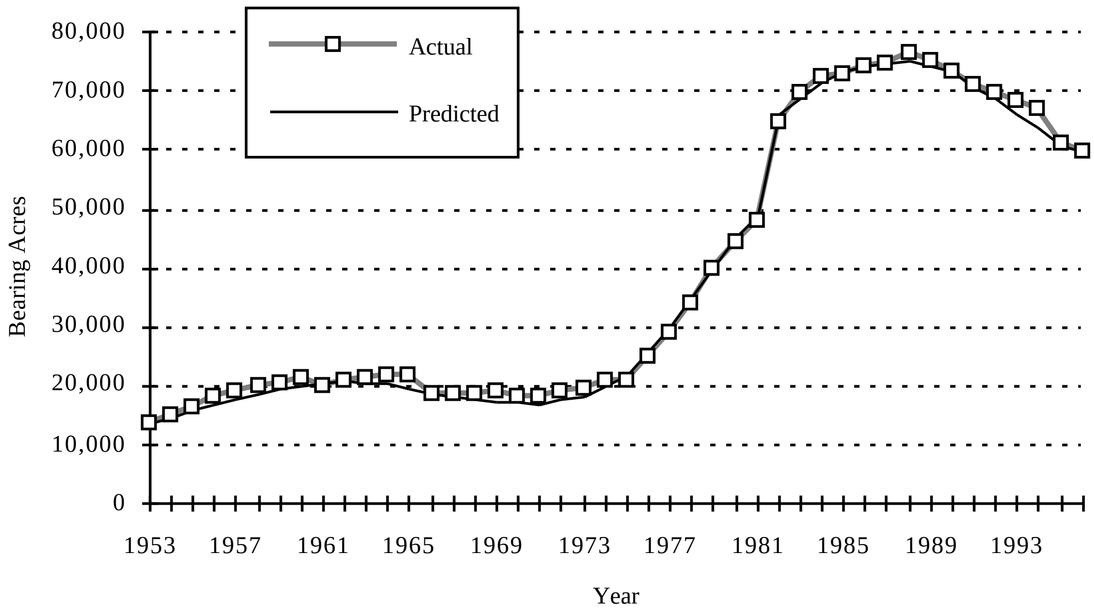

Figure 6. Bearing Acreage of California Avocados, Actual versus Predicted, 1953-96

<u>Conclusions</u>

Annual production of California avocados is the product of bearing acreage and average yields. Average yields are largely determined by factors outside the control of producers and vary significantly from year-to-year. Bearing acreage, on the other hand, is the direct result of producers' past decisions on plantings and removals and it tends to trend up or down over time.

Analysis of avocado yields over time permits several observations. After trending up for many years, average yields tended to level off and become more variable. No trends in yields are presently evident, and we were not able to isolate significant alternate bearing tendencies. Average yields tend to vary by variety, with the Hass variety having the largest average yields. Tentative explanations for the recent absence of an upward trend and increased variability of average avocado yields include recent sharp increases in water costs in many production areas, an increasing average

age of bearing groves, and the possible expansion of plantings on land that may not be ideally-suited for avocado production because of climate, soil quality, or topography.

The major components of avocado acreage response, including plantings, removals, total acreage, and bearing acreage were examined in some detail with generally consistent results. An average of recent total revenues per acre deflated by the producer price index was an important determinant of new plantings. The most statistically significant determinant of removals was acres of bearing trees. The variables used to explain plantings and removals were combined in an equation to estimate the annual change in bearing acreage, with time lags to account for the time required for a newly planted tree to reach bearing age. These variables, combined with variables to account for the impact of favorable income tax laws and high water costs on plantings and removals, explained 92 percent of the variation for annual changes in bearing acreage.

The Demand for California Avocados

Since the production of avocados during a marketing year is determined by decisions and events occurring in previous time periods, and because avocados are largely consumed fresh and not stored from one crop year to the next, the quantity of avocados placed on the market in a given year is essentially predetermined. Given these conditions, the annual demand for avocados is best expressed in the price dependent form (the inverse demand model), with the annual price of avocados being explained by available quantities and other factors. Along with quantity, the key factors explaining demand include prices of related goods, the purchasing power of potential customers, the size of the market in terms of number of consumers, and consumer tastes and preferences. This section presents a broad overview of historical data that characterizes and explains the annual demand for California avocados and then formalizes the relationships with an econometric model.

Characteristics of the Demand for California Avocados Over Time

Figure 7 graphs the average annual farm-gate price of California avocados in both nominal and real dollars for the 1962-95 time period.[8] Panel A of the figure shows that nominal avocado prices were quite variable throughout most of the period but there was a distinct upward trend in

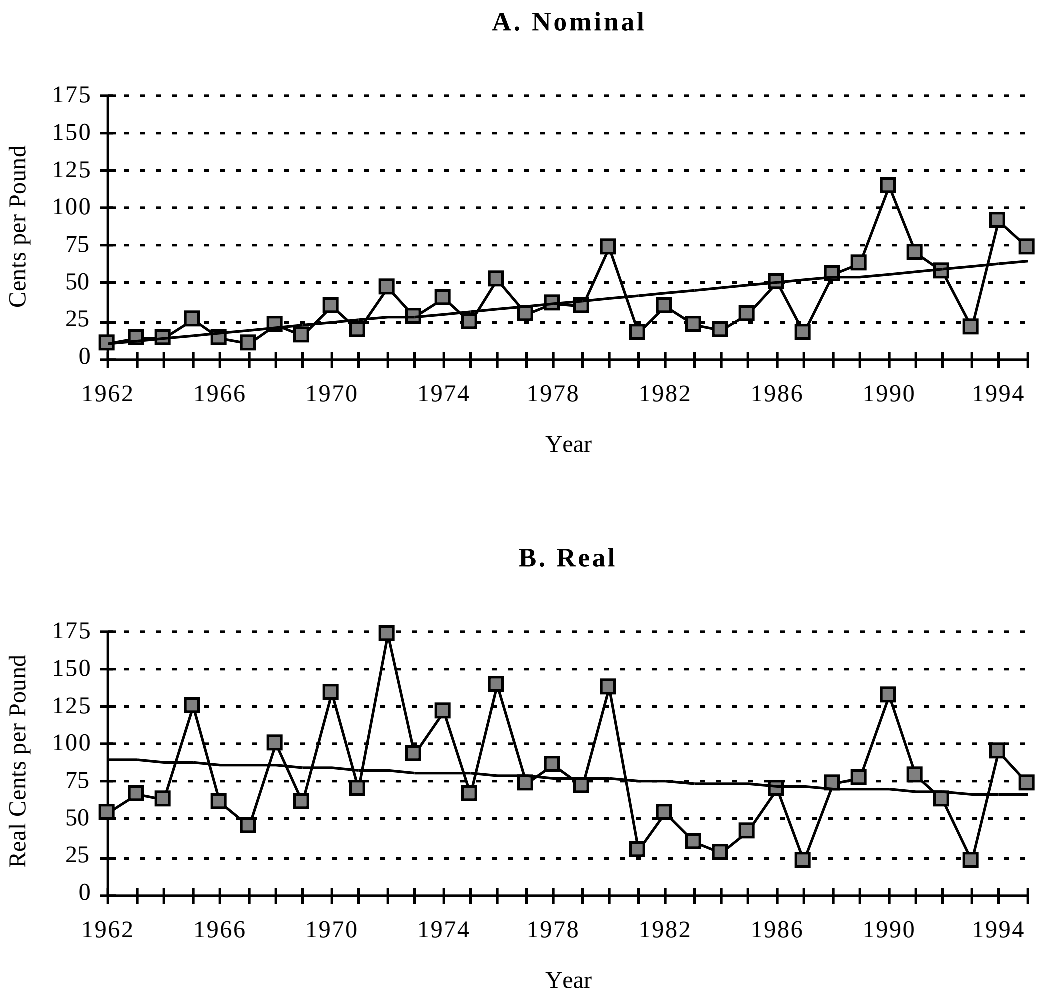

Figure 7. Average Annual Price of California Avocados in Nominal (A) and Real (B) Cents per Pound (1995=100)

these prices (solid lines in the figures are linear time trends fit with ordinary least squares). For instance, nominal prices increased from an average of $0.16 per pound in the 1960s (1962-69) to

[8] The nominal price was adjusted for inflation using the consumer price index (CPI) for all items with 1995 as the base, obtained from *The Economic Report of the President* and recent issues of *The Survey of Current Business*.

an average of $0.72 per pound in the 1990s (1990-95). Price variability also increased over the time span; the standard deviation of prices was 0.06 in the 1962-69 period and 0.32 for 1990-95. The picture changes markedly when prices are adjusted for inflation (panel B). In real terms, prices appear to have a roughly constant mean and variance over time. Some broad tendencies are evident, however, as inflation-adjusted prices were relatively high and variable throughout most of the 60s and 70s (averaging $0.92 per pound, with a standard deviation of 0.36, for the 1962-80 period), low and constant through the early and mid-80s (averaging $0.40 per pound, with a standard deviation of 0.17, for the 1981-87 period), and then generally higher and more variable again in the late 1980s and early 1990s (averaging $0.77 per pound, with a standard deviation of 0.31, for the 1988-94 period). The fitted linear time trend suggests that real prices tended to decline somewhat over the entire period.[9]

One of the most prominent factors explaining the price of avocados for a given time period is the quantity offered on the market. Figure 8 illustrates total California avocado production along with the average real price per pound for the 1962 through 1995 crop years. As shown in the figure, supply fluctuated dramatically around an increasing trend for the period, with annual variability largely due to average yields. Since 1981, however, there appears to have been little if any trend in production quantities and a substantial increase in annual variation. The "Law of Demand" holds that there is an inverse relationship between price and quantity, when everything else is held constant. Thus, an increase in supply to a free market will have a negative effect on prices provided all other determinants are fixed. This phenomenon is clearly seen in the avocado market, as real prices and quantities moved in opposite directions in nearly every year (the simple correlation coefficient for the two series is -0.68). Thus, changes in production clearly explain a great deal of the variation in avocado prices.

[9] The slope coefficient for the estimated trend line for the annual real price of California avocados was not statistically different from zero; thus, the results are consistent with the hypothesis of no trend in real prices.

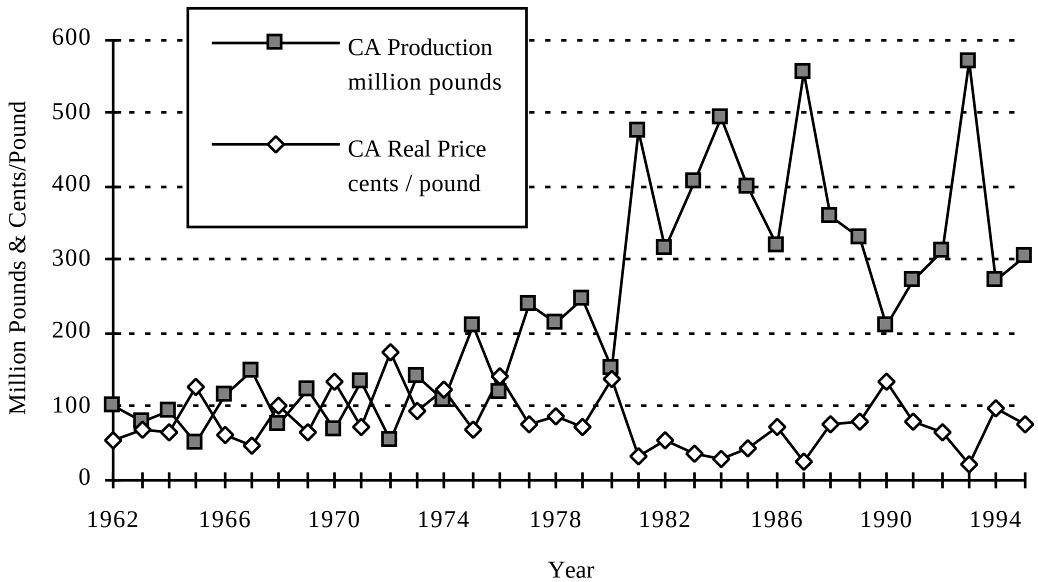

Figure 8. Annual California Avocado Production and Average Real Price (1995=100)

While avocado prices and quantities have an inverse relationship, gross annual revenues for California avocado producers trended upward at a considerable rate over the 1962-95 span (Figure 9). For example, in nominal terms the value of total farm sales of avocados averaged about $14.0 million per year for the 1962-69 period and increased over 14 fold to an average of $201.6 million per year for 1990-95. The rate of growth was less dramatic in real terms; nevertheless, inflation-adjusted annual crop values also trended upward strongly. The fitted linear time trend shown in panel B of Figure 9 (solid line) implies an average growth rate in the real value of annual California avocado crops of about 4.7 percent per year throughout the period under consideration.

A comparison of Figures 8 and 9 suggests an important point: producer-level avocado demand appears to be inelastic. This means that, all other factors equal, an increase in crop size will decrease both prices and total crop revenue while a smaller crop will increase prices and total crop revenue. Notice that since 1979, avocado quantity and real producer revenues moved in distinctly opposite directions in every year but one (1989). Thus, increases in production tended to be met with more-than-offsetting decreases in prices and reductions in total producer revenues; similarly, decreases in production tended to be met with more-than-offsetting increases in prices and a rise in total producer revenues.

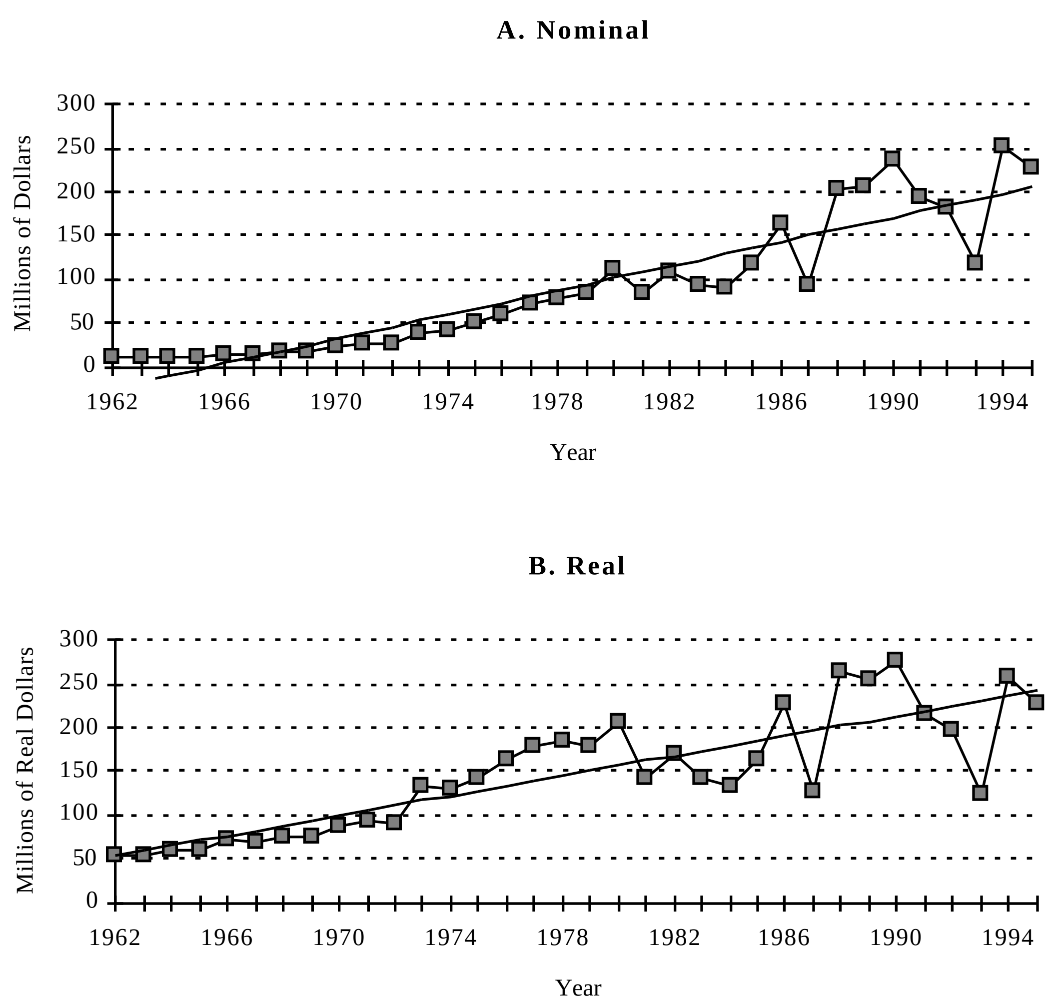

Figure 9. Gross Annual Value of California Avocado Crop in Nominal (A) and Real (B) Dollars (1995=100)

Other Factors Explaining the Demand for California Avocados

Abstracting from the irregular components of the time series discussed above, the general picture of the California avocado industry that emerges between 1962 and 1995 is one of real prices tending to decrease slightly, with quantities and total revenues increasing over time. This overview indicates that the inelastic producer-level demand for avocados has increased (shifted outward) over the period. Here we describe factors that can cause such shifts in avocado demand. In principle the demand for any good, such as avocados, is affected by the supply and demand relationships for all related goods, both complements and substitutes. For instance, complements tend to be consumed together, so that an increase in the price of one results in a decrease in the demand for both (and vice versa). Other goods may substitute well for each other in consumption, so that an increase in the price of one tends to induce consumers to switch to the other relatively cheaper product (and vice versa). Thus, demand analysis should account for the effects of production and price changes in complement and substitute goods. In the case of California avocados, avocados grown elsewhere might be considered as distinct yet closely related products. However, other related goods—those likely to have a statistically significant impact on avocado demand—have not been identified at this point.

The purchasing power of consumers, as represented by real disposable income, is another important explanatory factor in quantitative demand analysis. Economic theory predicts that as the income of market participants increases, avocado demand will increase as well, assuming that all

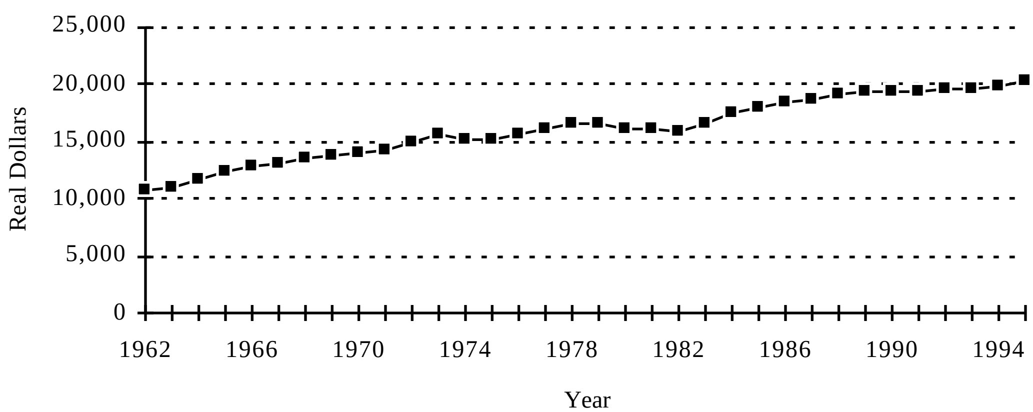

Figure 10. U.S. Disposable Income per Capita in Real Dollars (1995=100)

other factors are held fixed and that avocados are a "normal" good. Figure 10 shows a positive trend in U.S. real disposable income per capita for the 1962-95 period. In addition, cyclical periods of expansion and recession in the U.S. economy are reflected in per capita real income—the annual growth rate for the time period has a mean of 1.92 percent and a standard deviation of 2.17 percent. According to economic theory, the demand for avocados should be affected by these changes in consumer income.

The demand for California avocados may also be affected by supplies from other production regions. Figure 11 shows annual U.S. avocado production by location plus imports. As indicated, California typically accounts for 85 to 90 percent of total U.S. production, with Florida accounting for the remainder.[10] Historically, the quantity of avocados imported to the United States has been quite small. For instance, from 1962 through 1989 imports amounted to just over

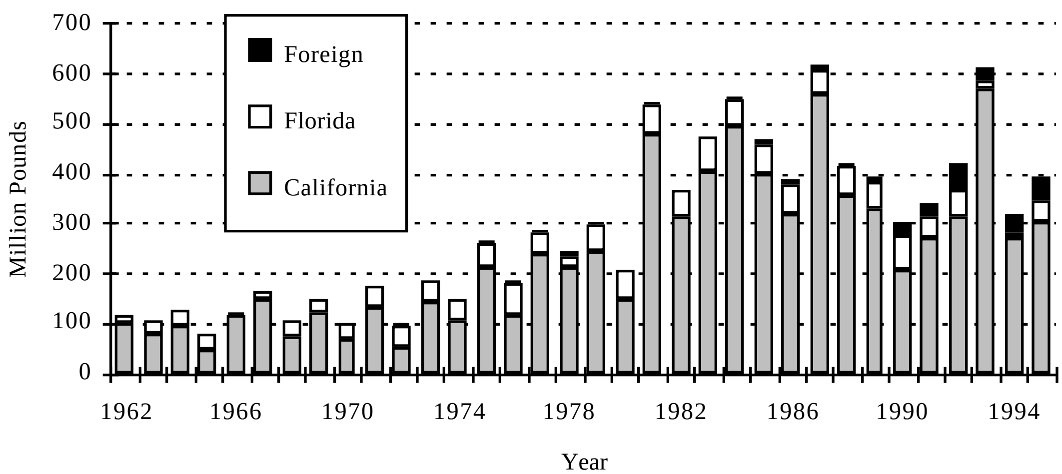

Figure 11. Total Annual U.S. Avocado Production by State, Plus Imports

one percent of annual U.S. production. Recent years, however, have seen substantial increases in foreign avocado purchases, with imports averaging over 10 percent of annual U.S. production since 1990. While California clearly dominates the U.S. market, avocado supply from Florida and foreign producers is significant and is expected to have a measurable (negative) impact on California prices.

[10] The state of Hawaii also has a small avocado industry that on average produces about 0.25% of the total U.S. crop.

All else being equal, total demand shifts proportionately with increases in the size of the market. In this study, the "market" for California avocados is assumed to be the entire U.S. economy; hence, the U.S. population is the explanatory factor representing the size of the market. It is no surprise to note that U.S. population increased steadily over all years under consideration in this report. Specifically, U.S. population increased from approximately 186.5 million persons in 1962 to approximately 263.1 million persons in 1995, with an average annual growth rate of 1.05 percent (the standard deviation of the annual growth rate for the period is 0.14). The steady expansion of population has, thus, exerted constant upward pressure on total demand which must be accounted for in modeling avocado markets.

Regarding the extent of the market, Figure 12 illustrates the percentage of California avocado shipments by U.S. regional destination for the 1994-95 crop year. As shown in the figure, nearly 40 percent of all California avocado shipments were intra-state that year. The next largest shipment destination was the Southwest, followed by the Pacific (excluding California), Northeast, East Central, West Central, Southeast, and Other. Note that the "other" category includes foreign exports amounting to about 1.7 percent of the total. This shipment distribution is assumed to be generally representative of historical patterns. Thus, while sales are heavily concentrated in the West and Southwest, the market for California avocados can be considered national in scope, with small amounts of foreign exports.

<u>Advertising and Promotion</u>

Advertising is the final factor posited to explain consumer demand for avocados. Industry advertising efforts are expected to increase demand through providing information and changing preference patterns. A major objective of this study is to determine the extent to which generic advertising programs conducted by the California Avocado Commission have been successful in shifting the demand for California avocados.

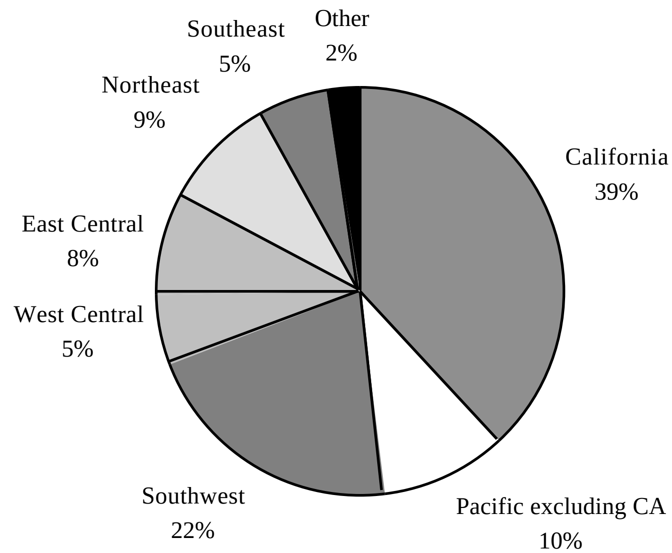

Figure 12. California Avocado Shipments by US Regional Destination, 1994-95 Crop Year

Notes: Regions are defined by the following city/area destinations: Pacific Region—Hawaii, Los Angeles, Phoenix/Tucson, Portland, Sacramento, San Diego, Seattle, San Francisco, Salt Lake City; Southwest Region—Albuquerque, San Antonio, Dallas/Ft. Worth, El Paso, Houston, McCallin, Oklahoma City; West Central Region—Denver, Kansas City, Minneapolis/St. Paul, St. Louis; East Central Region—Chicago, Cincinnati, Cleveland, Detroit, Grand Rapids, Indianapolis, Milwaukee; Northeast Region—Baltimore/Washington, Boston, Buffalo, Hartford/New Haven, Philadelphia, Pittsburgh, Richmond, New York; Southeast Region—Atlanta, Birmingham, Memphis, Miami, New Orleans, Orlando. Other includes other US destinations (0.7%), Canadian exports (0.1%), and overseas exports (1.6%). Source: 1994-95 AMRIC Summary Reports, California Avocado Commission.

The California avocado industry conducted generic advertising programs under a state marketing order from 1961 through 1977 and has operated under the California Avocado Commission law since 1978. The current Avocado Commission law allows a maximum producer assessment of 6.5 percent of the gross dollar value of the year's sale of producer avocados to support all Commission activities, including production research, industry affairs, marketing programs, and administration. It also provides that expenditures for administrative purposes within the maximum assessment shall not exceed 2.5 percent of the gross dollar value of sales. Actual grower assessments during the 1990s have been substantially below the allowable maximum, ranging from a low of 3.0 percent in 1990-91 to a high of 5.25 percent in 1992-93. The average annual assessment for the five crop years 1990-91 through 1994-95 was 4.05 percent. A key point that we will return to later is that the legislation does not contain provisions for controlling the supply of avocados placed on the market.

A review of annual reports of the marketing order and commission programs indicates that the industry spent over $116 million on advertising, promotion, and related services ("marketing expenditures") from initiation of the program in 1961 through the 1994-95 marketing year. Figure 13 gives total annual marketing expenditures in nominal and real dollars. Since available funds are

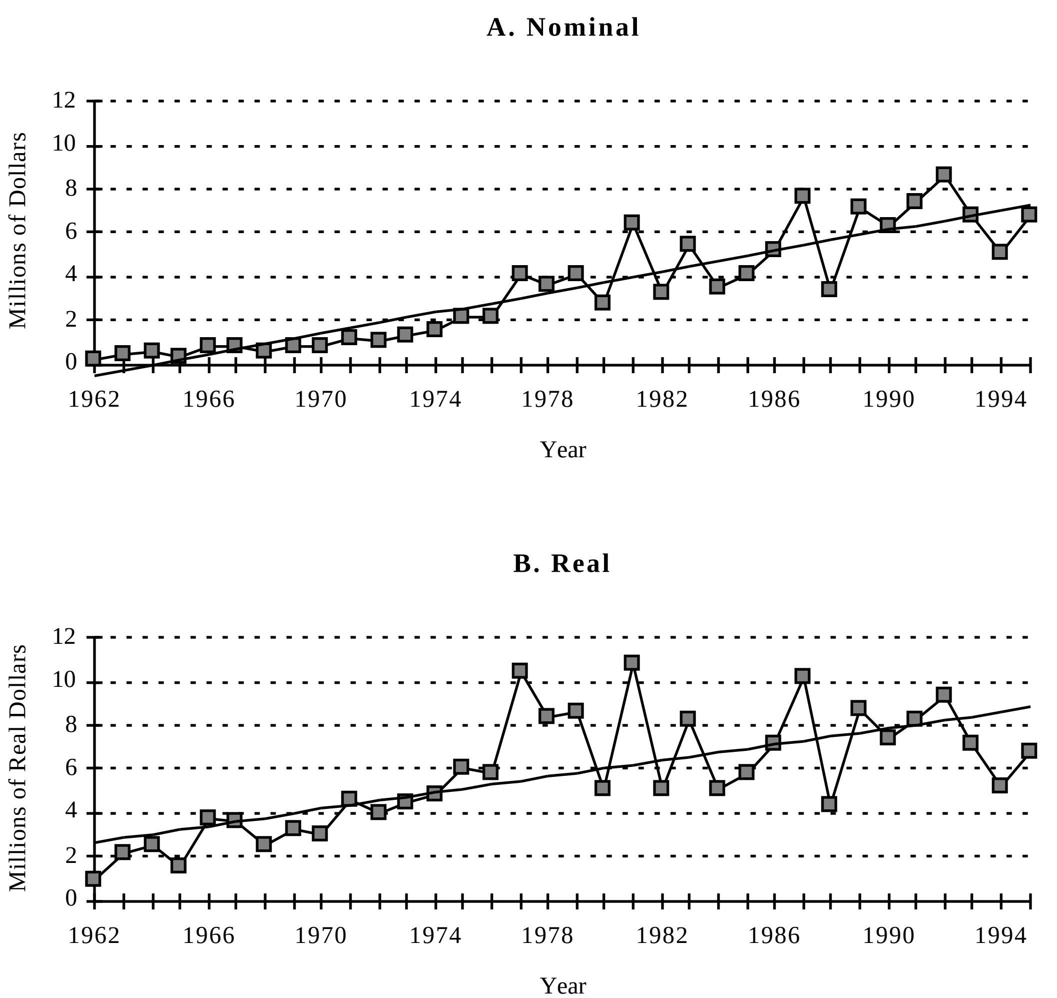

Figure 13. California Avocado Industry Annual Marketing Expenditures in Millions of Nominal (A) and Real (B) Dollars (1995=100)

based on producer revenues, marketing expenditures followed gross crop values fairly closely over the period (compare Figure 13 with Figure 9). In fact, the correlation coefficient between marketing expenditures and the prior year's crop value is 0.83 in terms of levels and 0.50 in terms of annual rates of change, verifying the expected positive relationship.[11] Thus, program outlays trended upward throughout the period in both nominal and real terms. The overall rate of increase was, however, less than that of gross crop value. For instance, the real trend line in Figure 13, panel B, increases at an average annual rate of 3.7 percent, one percentage point below the trend line for real producer revenue. In addition, it should be noted that there appears to have been little trend in real marketing expenditures since 1977.[12]

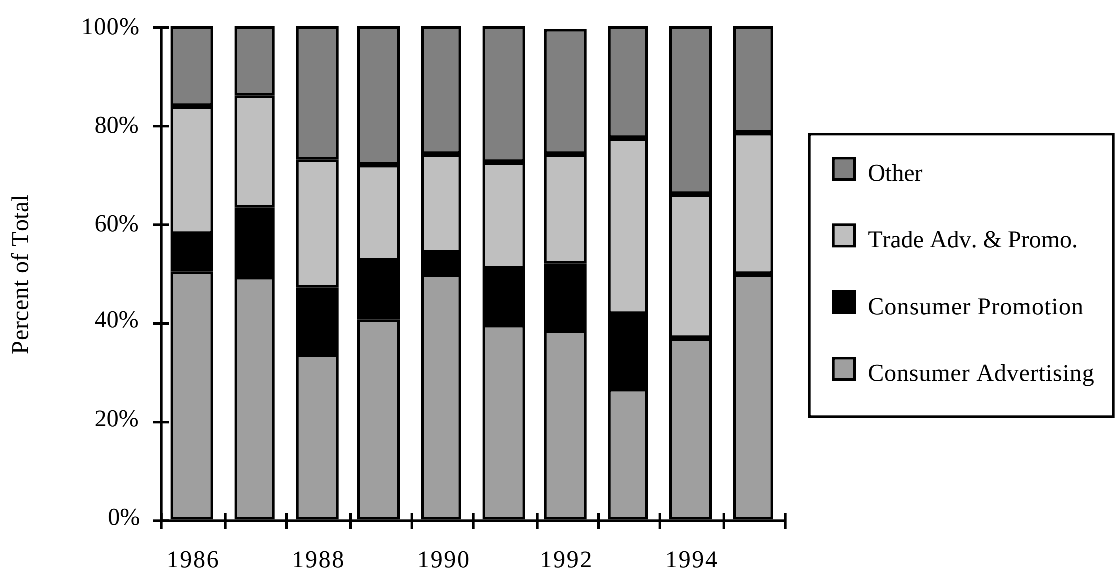

Figure 14. California Avocado Industry Annual Marketing Expenditures by Category, 1986-95

[11] If the common trend is accounted for, there does not appear to be a strong relationship between marketing expenditures and the *current* crop value. For instance, the correlation coefficient is 0.60 in levels and -0.32 in annual rates of change. This is an important point for the econometric estimation that follows.

[12] Note that proportion of CAC expenditures on marketing programs and administration has decreased in recent years as expenditures on industry programs (production research, industry affairs and anti-theft programs) increased. Comparing the average distribution of expenditures for two five-year periods, 1985-86 through 1989-90 with 1990-91 through 1994-95, shows that marketing program's share decreased from an annual average of 78.5 percent to 72.2 percent and administration's share decreased from 10.5 to 9.5 percent. At the same time the share for industry programs increased from 11.0 to 18.3 percent.

Specific marketing efforts conducted on behalf of California avocado producers have taken a variety of forms. For instance, in their annual reports the California Avocado Commission breaks total marketing expenditures into the following seven categories: consumer advertising, consumer promotion, trade advertising, foodservice, public relations, international promotion, and processed products. Figure 14 shows the relative allocation of marketing funds by four major categories (consumer advertising, consumer promotion, trade advertising, and all other) from 1986 through 1995. Overall, consumer advertising received the greatest percentage of funds (averaging 41.4 percent for the period), followed by trade advertising (25.1 percent), other (24.2 percent), and

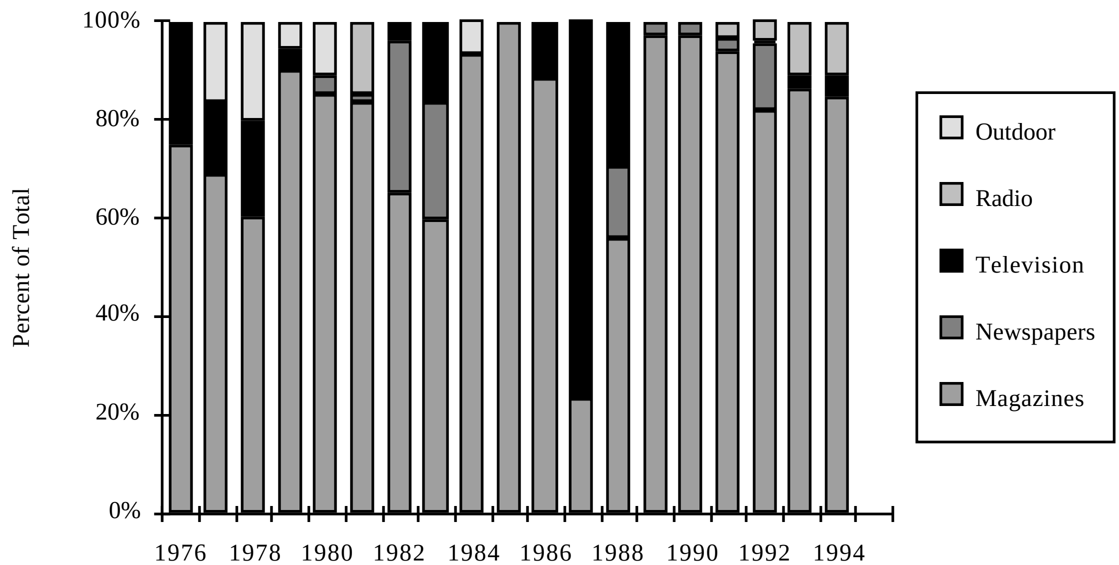

Figure 15. California Avocado Industry Annual Advertising by Media Type, 1976-94

consumer promotion (9.3 percent). Year-to-year allocations varied somewhat but for the most part remained fairly constant, especially if consumer advertising and promotion are considered together. Figure 15 illustrates the relative allocation of California avocado advertising dollars by media type from 1976 through 1994 (1995 data were unavailable). The chart clearly shows magazine advertising dominating other media types by a substantial amount, receiving on average 78 percent of all advertising dollars for the given period. [13] Moreover, magazines were the only advertising media used prior to 1976. The chart suggests that program administrators experimented with other media, varying fund allocation among television, newspapers, outdoor displays, and radio from year to year. However, in most years media other than magazines accounted for only small portions of the advertising effort; a notable exception is the television campaign of 1987 which accounted for over 75 percent of advertising funds that year.

While the effectiveness of generic avocado marketing efforts may depend on the specific program implemented, a thorough analysis of the issue requires more detailed data than that considered here. Figures 14 and 15 imply that there are not enough disaggregated annual observations to isolate the effects of different types of marketing expenditures. Hence, in this report we examine the effects of all marketing expenditures together and refer to them simply as "advertising" or "advertising and promotion".

An Econometric Model of Annual Avocado Demand

In this section we formalize the basic concepts discussed above by developing and testing an econometric model of annual avocado demand. The complete set of data used to model the demand relationship is given in Appendix Table 6. As shown, the variables consist of 34 annual observations from 1962 through 1995 corresponding to the factors described above.

Model Specification

Specification of the empirical demand model must be based on theory, data availability, and statistical feasibility. Given these considerations, the annual demand for avocados was assumed to be represented by the following general function:

$$Pc_t = f(Qc_t, Qf_t, Qm_t, Y_t, A_t) \qquad (7)$$

[13] Information on advertising expenditures by media type was obtained from an independent marketing research firm (LNA-Mediawatch). Also note that these data are based on a calendar year, while data reported by California marketing order and commission program administrators are based on a California crop year (November through October).

where for a specific year t, Pc_t is the farm-gate price of California avocados, Qc_t is total sales of California avocados, Qf_t is total sales of Florida avocados, Qm_t is total avocado imports, Y_t is disposable income, and A_t is advertising expenditures. Precise definitions and descriptive statistics for each variable are given in Table 5. We follow the accepted practice of assuming demand is

Table 5. Definitions of Variables Used in Annual Demand Model

Variable	Definition	Units	Mean Value	St Dev
Pc_t	average annual producer price of California avocados deflated by the consumer price index for all items (1982-84=100)	real cents per pound	51.286	24.834
Qc_t	per capita sales of California avocados during the marketing year	pounds per capita	1.0120	0.5888
Qf_t	per capita sales of Florida avocados during the marketing year	pounds per capita	0.1862	0.0705
Qm_t	per capita imports of avocados during the marketing year	pounds per capita	0.0327	0.0484
Y_t	U.S. per capita disposable income deflated by the consumer price index for all items (1982-84=100)	thousands of real dollars	10.457	1.7392
A_t	annual avocado advertising expenditures deflated by the consumer price index for all items (1982-84=100)	millions of real dollars	3.7405	1.7655

Notes: variables consist of 33 annual observations, 1962-94, based on a California crop year with timing adjustments as per discussion in text; data sources given in Appendix Table 6.

homogeneous of degree zero in money income and prices; hence, all dollar-denominated variables are expressed in real terms using the consumer price index as a deflator.[14] In addition, the quantity variables and income are given in per capita terms to account for the effect of population on demand. The advertising variable is expressed in real terms but is not adjusted for population growth.[15]

[14] Demand is assumed to be homogeneous of degree zero in money income and prices. We convert advertising expenditures into real terms using the same deflator. While this is common practice, it is not ideal. We would prefer to deflate the A_t variable with an index of the price of advertising, if one were available, so as to obtain a measure of the *quantity* of advertising.

[15] Theoretically the advertising variable should not be adjusted for population if it is more like a type of "public good" than a "private good." A good is called a public good if (1) certain people cannot be excluded from consuming it (nonexcludable) and (2) one person's consumption does not diminish that available to others (nonrival). Advertising conducted through mass media clearly has features of a public good. On the other hand, advertising has features of a private good when its cost depends on the number of customers reached. We decided the advertising efforts of the California avocado industry have been more like a public good than a private good from the point of view of consumers. However, the demand model was also estimated with the A_t variable defined in per capita terms and it had little effect on the results. (The authors thank Julian Alston for bringing the private-good versus public-good point to our attention.)

In many market models, prices and quantities traded are determined jointly through the simultaneous interaction of supply and demand functions. In this case, quantity is said to be an *endogenous* variable, meaning that it does not contribute to the explanation of the price level *independently* but rather is something to be explained together *with* price by the economic model. If an endogenous variable appears on the right-hand side of a regression equation, special estimation techniques must be used to account for the fact that it is not an independent explanatory factor. In the case of annual avocado demand, however, we assume that current-period California and Florida quantities are determined by prior-period production decisions and events independent of the current-period price. Thus, they are *predetermined*, rather than endogenous, variables.

On the other hand, the quantity of imports may well depend on the current-period price. It is reasonable to suppose that while foreign production is predetermined, a larger share enters the country when the domestic price is high and, hence, that Qm_t is endogenous. Nevertheless, it is possible that the statistical consequences of treating a theoretically endogenous variable as if it were an independent explanatory factor (exogenous) are negligible. Because the quantity of imports is very small relative to domestic avocado production, our strategy is to regard it as an exogenous variable and then perform tests to ascertain whether this simplification is likely to have important effects on the results.

Finally, since the funds available for advertising are based on producer revenue, and since producer revenue depends on price, the A_t variable might also be endogenous. This did not appear to be a problem in the present analysis. As alluded to above, our investigation found advertising expenditures to bear some relationship to the *previous* year's revenues, but very little to the *current* year's revenues—i.e., A_t was associated with Pc_{t-1} rather than Pc_t. In addition, the statistical relationship between advertising expenditures and producer revenues was diluted by circumstances: the avocado industry varied the percentage checkoff over time, the proportion of the total assessment used for advertising varied by year, and there was carryover of funds from year to year. Thus, we assume that the advertising can be treated as an exogenous or predetermined explanatory factor.

The annual demand model therefore assumes that price is not jointly determined with any of the explanatory variables, in the same period, and that simultaneous equations methods are not needed in estimation. Statistical tests of this assumption are discussed below.

Data Issues

A potentially serious problem has to do with the compatibility of the various series in the data set. California price, quantity, and advertising data are reported on a California crop year basis (November through October); Florida price and quantity information is reported on a Florida crop year basis (April through March); the import data are reported on varying annual bases (see the footnotes for Appendix Table 6); and the CPI, income, and population data are reported on a calendar year basis. Since the demand relationship is defined for a particular time period, these timing mismatches imply an error in model specification. To deal with this complication we first specify that the California crop year is the standard to which the other data should be matched. Since the CPI, income, and population series change rather smoothly from year to year and coincide with the California crop year except for two months, they are assumed to be acceptably matched with the corresponding year ending each California season. Thus, the Florida and import data appear to pose the main difficulties.

Shipments of Florida avocados by month were available for the 1984-85 through 1993-94 crop years. Using this information it was found that, on average, 38 percent of Florida shipments in a given Florida crop year coincided with the corresponding California crop year. For example, approximately 61 percent of Florida's 1984-85 shipments occurred between April 1 and October 31, 1984, while 39 percent occurred between November 1, 1984, and March 31, 1985—therefore, 61 percent coincided with California's 1983-84 crop year while 39 percent coincided with California's 1984-85 season.

Since the break-down for Florida shipments is not known for seasons prior to 1984-85, three separate Florida quantity variables were considered in the analysis. The first Florida quantity variable matches California and Florida observations according to the stated year; e.g., the Florida 1994-95 data is matched with California 1994-95 data. The second Florida quantity variable matches each Florida observation with the stated prior-year California observation; e.g., Florida 1994-95 data is matched with California 1993-94 data. For a third option we constructed a new Florida quantity variable by attempting to divide each observation on Florida production into some that belongs with the current and a remainder that belongs with the prior California crop year. This can be done precisely for those years in which monthly data are available (1984-85 through 1993-94). For other years the percentage of each Florida observation belonging with the corresponding California observation was estimated by averaging the observed percentages in the 1984-85 through 1993-94 period; thus, 38 percent of each Florida observation was assumed to match with the corresponding California crop year, while the remainder was assumed to match with the prior California crop year. Note that one observation is lost with the second and third options.

All three Florida quantity variables were used in the econometric model development. Surprisingly, the main conclusions did not change when different Florida quantity variables were used. Econometric results presented below are based on the second option (each Florida observation is matched with the stated prior-year California observation). It is important to note that each of the Florida quantity variables suffers from the errors-in-variables problem, which can have potentially serious implications for reliable econometric estimation. A test for the statistical importance of this difficulty is described below.

The compatibility problem is not as significant for import data because: (1) much of the import data is more closely aligned with the California crop year, and (2) imports were a small portion of total supply in those years in which the reporting year did not line up closely with the California crop year (i.e., prior to 1977). Nevertheless, minor realignments were made in the import series using monthly data from 1988 through 1995 and a method similar to that described above for Florida quantities. The adjusted annual import series is believed to coincide with California crop years exactly for the 1989-95 period, very closely for the 1977-88 period, and closely enough for practical purposes prior to 1977. It was therefore assumed to be an acceptable variable.

Model Estimation and Testing

To estimate the annual demand model, a functional form that characterizes the general relationship described above must be specified. Since choice of functional form can have important impacts on the results (e.g., Alston and Chalfant, 1991), we began by following Carman and Green (1993) in specifying an extended Box-Cox model—which implies a quite general functional form. Thus, the empirical demand model initially assumed is given by

$$Pc_t = \beta_0 + \beta_1 Qc_t + \beta_2 Qf_t + \beta_3 Qm_t + \beta_4 Y_t + \beta_5 A_t + \varepsilon_t \qquad (8)$$

where for each variable X_t, X_t symbolizes the Box-Cox transformation defined as $(X_t^{\lambda} - 1)/\lambda$ if $\lambda \neq 0$ and $\ln X_t$ if $\lambda = 0$. The ε_t term is assumed to be a normally distributed random error with zero mean and constant variance ($\varepsilon_t \sim N(0, \sigma^2)$). Note that the Box-Cox model encompasses the two most common specifications used in empirical analysis: $\lambda = 1$ implies a linear functional form and $\lambda = 0$ implies a log-linear functional form.

Using annual data for the crop years ending in 1962 through 1994, the parameters of the assumed model, β_i (i = 0 to 5) and λ, were estimated simultaneously with a procedure based on a statistical goodness-of-fit criterion (maximum likelihood), yielding the following results:

$$\begin{array}{lcccccccc} Pc_t = & -15.68 & -\ 5.61Qc_t & +\ 0.80Qf_t & -\ 2.00Qm_t & +\ 5.38Y_t & +\ 0.37A_t & +\ \varepsilon_t & \quad (9) \\ & (-2.79) & (-18.75) & (1.38) & (-2.08) & (6.04) & (1.65) & & \\ & & [-1.21] & [0.09] & [-0.11] & [2.89] & [0.13] & & \end{array}$$

$$\lambda = 0.39, \quad R^2 = 0.94, \quad D.W. = 1.45,$$

where numbers in parentheses are t-statistics and the numbers in brackets are the price flexibilities of demand with respect to the corresponding variables, evaluated at the data means.

The estimated coefficients in Box-Cox models are of little interest since they apply to the transformed rather than the original variables. We therefore report the estimated price flexibilities of demand defined as the percentage change in price resulting from a one percent change in a given explanatory factor.[16] For example, the estimated model implies that a one percent increase in advertising expenditures will result in an approximately 0.13 percent increase in the price of California avocados, at average levels of price and advertising in the sample data.

The coefficients on Qc_t, Qm_t, and Y_t have the expected signs and are statistically significant at the 95 percent confidence level (or better). The coefficient on Qf_t has the "wrong" sign—it was expected to be negative—but is not statistically significant. The coefficient on A_t has the expected sign but is not statistically significant.

The R^2 statistic implies that the estimated equation generally fits the data well. However, the D.W. (Durbin-Watson) statistic suggests that the error term may be autocorrelated; if so, it does not satisfy the assumptions under which the equation was estimated and, hence, there is a problem with the model. Since the value of the D.W. statistic is in the inconclusive range, a second test was performed which gave strong evidence that the regression errors do exhibit a high degree of autocorrelation (Savin and White, 1978).[17] Seemingly autocorrelated errors can be the result of model misspecification (incorrect functional form or omitted explanatory variables) or the errors may actually follow an autoregressive process. The former calls the entire model into question while the latter makes the conventionally calculated t-statistics invalid. Thus, a remedy was sought.

Examination of alternative functional forms found that a variation on the originally estimated Box-Cox model performed well. Rather than all variables being transformed by the λ parameter as in the first regression (called the *extended* Box-Cox model), the alternative model transforms only the dependent variable (called the *classical* Box-Cox model).[18] The results from estimating the

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[16] For the general Box-Cox model, it can be shown that the price flexibility of demand with respect to one of the explanatory variables, say x, is given by

$$\eta_x = \beta_x \frac{x^{\lambda_x}}{y^{\lambda}}$$

where λ is the estimated Box-Cox parameter for the dependent variable (y) and λ_x is the estimated Box-Cox parameter associated with explanatory variable x.

[17] Following Savin and White (1978) the joint hypothesis of λ unrestricted and $\rho = 0$ (the first-order autocorrelation coefficient) was tested against the alternative of λ and ρ both unrestricted yielding $\rho = 0.84$ and $\chi^2 = 19.13$.

[18] Note that the classical Box-Cox model is not nested by the extended Box-Cox; hence, choosing between the two cannot be accomplished with straightforward tests on restrictions. Due to computational difficulties, we were unable to estimate the Box-Tidwell model, where every variable may have an unique transformation parameter and which therefore encompasses both Box-Cox models described here.

classical Box-Cox model were:

$$Pc_t = \underset{(18.37)}{1.91} - \underset{\substack{(-20.22) \\ [-1.33]}}{0.53Qc_t} + \underset{\substack{(0.70) \\ [0.06]}}{0.14Qf_t} - \underset{\substack{(-2.96) \\ [-0.10]}}{1.23Qm_t} + \underset{\substack{(7.51) \\ [2.77]}}{0.11Y_t} + \underset{\substack{(1.53) \\ [0.13]}}{0.01A_t} + \varepsilon_t \qquad (10)$$

$$\lambda = -0.23, \quad R^2 = 0.95, \quad \text{D.W.} = 2.11,$$

where, as before, numbers in parentheses are t-statistics and the numbers in brackets are the price flexibilities of demand with respect to the corresponding variables, evaluated at the data means.

The first thing to note about these results is that the estimated flexibilities and t-statistics are very close to those estimated with the extended Box-Cox model; thus, our conclusions about both the economic and statistical significance of each explanatory variable are essentially the same. Moreover, the R^2 statistic indicates that the classical Box-Cox fits the data to basically the same degree as the extended model. In a statistical sense, the key difference between the two models is that autocorrelation does not seem to be a problem with the classical Box-Cox. The D.W. statistic implies that the errors are not autocorrelated and the test of Savin and White (1978) confirmed this finding.[19] These results suggest that incorrect functional form was the cause of autocorrelation in the extended Box-Cox regression, that the classical Box-Cox corrects the problem, and therefore that the latter is a better model.

There is a possible difficulty with this conclusion however (which is the reason why we report both models). Contrary to the extended Box-Cox model, the estimated classical Box-Cox function implies that price increases at an increasing rate as the explanatory variables increase. Thus, as the level of advertising rises, each unit increase results in a greater change in price than did previous unit increases. Clearly, this functional form cannot prevail for all levels of advertising. Economic theory and common sense prescribe that there must be diminishing marginal returns to advertising after some point and, moreover, that the optimal level of advertising is in the range of diminishing

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[19] The joint hypothesis of λ unrestricted and $\rho = 0$ was tested against the alternative of λ and ρ both unrestricted yielding $\rho = -0.33$ and $\chi^2 = 1.04$.

returns. If one assumes that the avocado industry is in equilibrium and behaving rationally, the extended Box-Cox regression model which exhibits decreasing returns would be preferred. It is quite possible, however, that the CAC has been operating in the area of increasing returns because of previously limited information on the impact of its advertising on avocado prices. In other words, it may be extremely difficult for a commodity organization such as the CAC to determine the nature of returns to advertising without detailed empirical analysis.

A common hypothesis in the marketing research literature is that market response to advertising is S-shaped (e.g. Little, 1979; Lilien, et al., 1992). The concept is illustrated by the hypothetical market response function in Figure 16. Initially the market responds (e.g., price

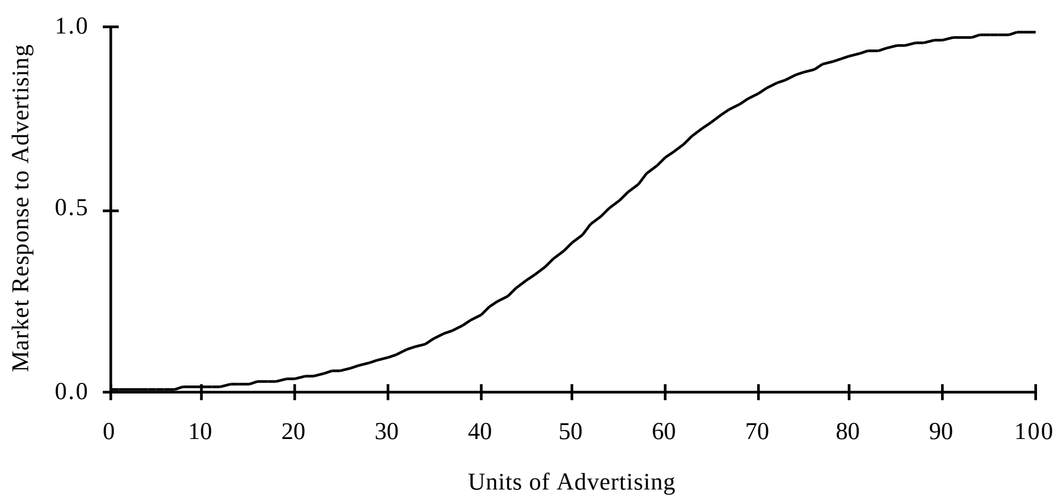

Figure 16. Hypothetical Market Response to Advertising

changes) slowly to advertising as low levels are applied. For levels of advertising below 50 units, the market responds at an increasing rate; for levels of advertising above 50 units, the market responds at a decreasing rate. By 100 units, advertising has reached a saturation point at which more effort has negligible effects. Thus, the theory asserts that price can exhibit both increasing and decreasing marginal returns over different ranges of advertising.

Considering our estimation results from this perspective suggests the possibility that advertising efforts in the California avocado industry over the 1962-94 time period were in the range of increasing returns (i.e., corresponding to advertising levels below 50 in Figure 16). If this is the case, then the appropriate model is the classical Box-Cox. However, while it may be appropriate for past levels of advertising, it would not be applicable for higher and higher levels of advertising. In addition, if it is believed that observed advertising expenditures are at or near optimal levels, then a regression model exhibiting constant or increasing returns is not satisfactory since the optimal advertising level must be in the region of diminishing returns.[20]

Further Tests of the Classical Box-Cox Regression Model

A number of statistical tests were performed to further examine the adequacy of the classical Box-Cox regression model. We report those results here without going into much detail. Note that all tests are conditional on the estimated model.

First, recall from previous discussion that there was some concern about the statistical consequences of Qm_t and A_t being, possibly, endogenous factors. A closely related issue is whether the measurement error know to exist in the Qf_t variable has important implications for the results. These questions were examined by means of the Hausman test (see Kmenta, 1986, pp. 365-66 and 717-18). A series of such tests were performed using alternatively constructed instrumental variables. In all cases, the results strongly supported our assumption that Qm_t and A_t can be treated as effectively exogenous factors. On the other hand, the results of testing for the seriousness of measurement error in Qf_t (Florida avocado sales) were mixed. Since nothing more can be done to improve the Qf_t variable at this time, we simply acknowledge the fact that measurement error may be a problem.

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[20] Because of our particular interest in the effects of advertising, a third model was estimated which allowed both the dependent variable and the advertising variable to each have unique Box-Cox parameters, while all other variables were restricted to be untransformed (for computational feasibility). Many of the key results were quite similar to the other two models (model-fit statistics, precision of the parameter estimates, values of estimated elasticities at the data means, etc.). However, the estimated Box-Cox parameter associated with the advertising variable was very large ($\lambda_A \approx 31$) implying an extremely convex functional form. We rejected the model because of the implausible implications of its extreme shape. Nevertheless it is worth noting that there is evidence to suggest that the price function should possibly be more convex with respect to advertising (i.e., exhibit greater increasing marginal returns) than our current model indicates. Allowing for this increases the *statistical* significance of the advertising variable (i.e., yields larger t statistics on A_t). In addition, it implies that advertising had generally less economic significance at historical levels (i.e., lower price flexibilities at most observed data points), but would have greater economic significance at higher levels.

A condition of the error term called heteroskedasticity is similar in nature and consequences to autocorrelation. Its presence means that the regression error does not have a constant variance across the range of the dependent variable. Heteroskedasticity can be caused by model misspecification or it can be a characteristic of the true data generating process. In either case, corrective measures are necessary. Our econometrics program generates a number of test statistics for heteroskedasticity (e.g., the Goldfeld-Quandt test, the Breusch-Pagan test, Harvey tests, etc.; see any econometrics textbook for a description). All were considered and none suggested a problem with heteroskedasticity.

Along with the specification tests implicitly conducted through examination of the error term, the RESET method was used to test the hypothesis that no relevant explanatory variables were omitted from the regression equation (Kmenta, 1986, pp. 452-54). The hypothesis was accepted.

It is important to consider that the economic processes generating observed data may change fundamentally at certain points in time (i.e., structural change). For example, over the time period covered by the analysis, structural changes may have occurred in the effect of advertising due to such things as advertising media used, the nature of advertising copy, competitive conditions, and consumer response. For empirical modeling, structural change implies that the appropriate regression coefficients, and possibly even functional form, may be different for different time periods. A time-varying parameters model, such as employed by Ward and Myers (1979), can be used to test for the effect of such changes. However, there was no “event” in the avocado industry that pointed to a specific point of potential change. A general test (i.e., a sequential Chow test) suggested the possibility of structural change at or around 1974-75. However, attempts to model the phenomenon using standard approaches produced inconclusive results.

Finally, we note that it is reasonable to assume that the impacts of advertising extend over some period of time and, hence, that this dynamic response should be accounted for in the regression model. However, determination of the nature and duration of the lagged effect is difficult. Nerlove and Waugh (1961) used an average of advertising expenditures over the ten years preceding year t in their study of orange advertising. More recent research indicates that the carryover effect is probably much shorter than ten years, and may, in fact, be less than one year. Clarke (1976) concluded that "90 percent of the cumulative effect of advertising on sales of mature, frequently purchased, low-priced products occurs within 3 to 9 months of the advertisement." Reynolds, McFaul and Goddard (1991) investigated lagged advertising effects of up to six quarters for Canadian butter and cheese. They found optimum lag orders, determined by minimizing Akaike's Final Prediction Error, of five quarters for cheese and one quarter for butter. Other authors have specified comparatively short lag structures. Kinnucan and Forker (1986) specified a Pascal distribution for a "goodwill" variable to capture the impact of current and past advertising expenditures and assumed that advertising expenditures contributed to goodwill for only six months. Ward and Dixon (1989) specified a twelve month, second-degree polynomial lag model on advertising with both ends of the lag structure constrained to zero. Since the estimated model utilized annual data, one would expect little carryover of advertising effects from one year to the next. As partial verification, a model including lagged effects of advertising was estimated. The estimated coefficients for one and two year lags were not statistically different from zero and, thus, variables for lagged effects of advertising were not included in the final model estimated. We do, however, expect to find lagged effects from advertising expenditures when moving to a monthly period of analysis.

Conclusions

While there are some theoretical concerns about the implications of increasing returns to advertising, the classical Box-Cox regression is our preferred model. In most respects the model is statistically sound and logically consistent. We therefore use the results from the classical Box-Cox regression model to draw inferences about the annual demand for California avocados during the period from 1962 through 1995.

As expected, the model indicates that the quantity of avocados offered on the market is an important explanatory factor, having a precise, negative impact on price. The estimated price flexibility of demand of -1.33 (at the data means) indicates that the price elasticity of demand is approximately -0.75, implying avocado demand is inelastic as predicted.

We expected Florida avocados to be competitive with California avocados, with increased sales of Florida avocados having a negative impact on the price of California avocados. The coefficient on the quantity of Florida avocados, however, has a positive sign, but is not statistically different from zero. There are at least two possible explanations for this outcome. First, it might be the result of the data inconsistencies previously discussed in some detail. Second, it may be that the timing of Florida shipments makes them sometimes competitive and sometimes complementary with California avocados *within* the same year. For instance, if Florida avocados tend to be in greater supply when California avocados are in relatively low supply, their availability may help keep consumers in the habit of purchasing avocados and hence have a complementary effect on California demand. More detailed data are needed to resolve this issue.

Imports were found to have a statistically significant negative impact on California avocado prices. This indicates that foreign avocados compete directly with California avocados for consumer dollars. Disposable income was found to have a very large and significantly positive impact on avocado prices, indicating that avocados are a normal good.

Finally, the classical Box-Cox regression model indicates that advertising has had a positive impact on California avocado prices. While the value of the t-statistic for the estimated advertising coefficient is relatively close to the critical value, it is not statistically significant at the usual confidence levels (95 percent or better). This result does not lead to the conclusion that advertising is ineffective. Rather, it implies that, with the available annual data and assumed model, our estimates are not precise enough to conclude with 95 percent certainty that the advertising coefficient can not in fact equal zero. We strongly believe that improved data will increase the precision of our estimates of the effects of advertising.

Because of the data limitations noted above, a significant effort was made to obtain monthly data on each of the variables examined in the annual model of demand. We were successful in obtaining a complete set of monthly observations for the most recent nine years (November 1986 through October 1995). In the next section we specify a monthly demand model for California avocados and use these data to derive estimates of the model parameters. This will provide confirmation of the annual results and it should also improve the precision of some of our estimated coefficients.[21]

An Econometric Model of Monthly Avocado Demand

A complete monthly data series for California avocado sales, prices, and advertising/ promotion expenditures was assembled for the nine-year period 1986-87 through 1994-95. When combined with data on consumer income, quantities of Florida and imported avocados, prices of possibly related goods, and brand advertising, these data can be used to estimate a monthly version of the previously estimated annual demand model for California avocados.

A monthly analysis of the demand for California avocados, with emphasis on the impact of generic advertising and promotion, offers a number of potential advantages over the just-completed annual analysis of demand. First, there should be a definite improvement in the quality of the data and in the precision of the econometric estimates. The monthly data will be for a shorter time period when data collection procedures were improved, they will be much more consistent in terms of classification and measurement, and they will provide an increased number of observations. Second, monthly data will permit more detailed analysis of issues such as the response to various types of marketing expenditures, and the carryover effects of avocado advertising and promotion. Third, monthly data will facilitate matching variables such as sales from different production areas, that did not match exactly with differing crop and marketing years. In the annual analysis, it appeared that important relationships related to seasonality of supply by production area, possible seasonal demand, and varietal differences were masked by the annual data. There are, however, possible disadvantages to moving to a shorter time period. The most obvious is that a reduced range of variation for the independent variables, such as consumer income or prices, may reduce the statistical significance of some estimated coefficients.

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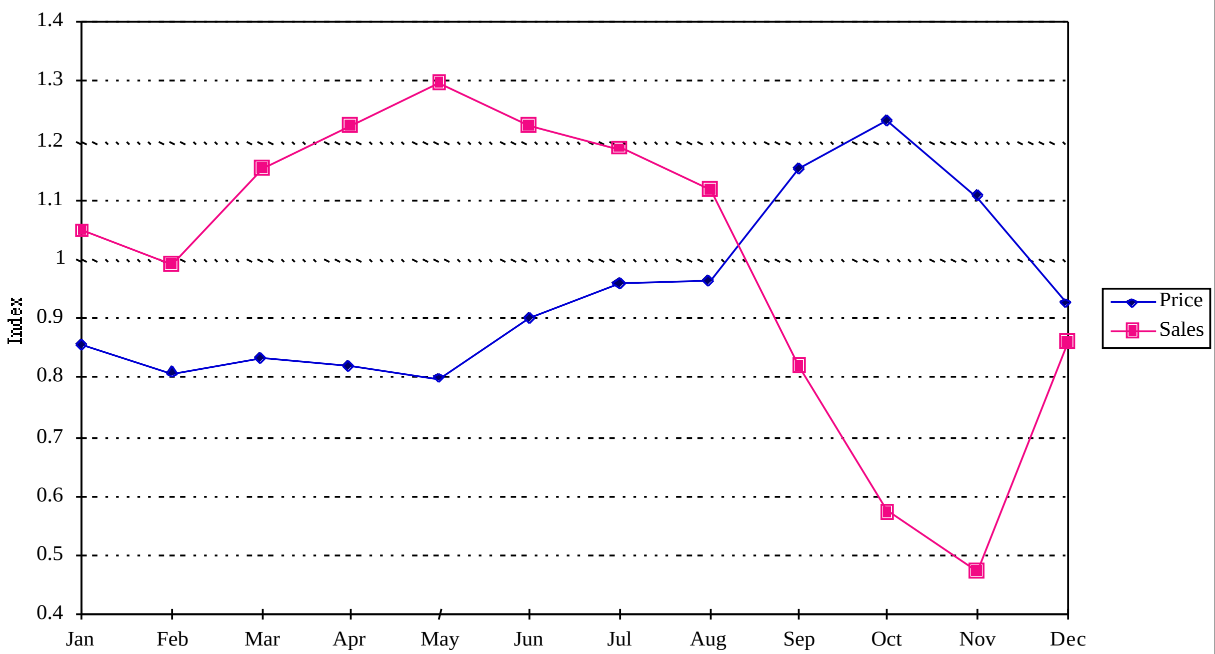
[21] We alluded to possible problems with the data series on marketing expenditures. These problems include the changing composition and categories of expenditures included over time. For example, administration and marketing research are necessary expenditures, but neither are expected to directly affect demand. The relative importance of these and other similar categories of expenditures change over time, with the result being an advertising variable whose measurement is subject to possibly large unexplained variability.

Seasonal Sales and Prices

Seasonal patterns of avocado production and sales in California and other areas, combined with possible seasonal changes in demand, result in changing prices over the marketing year. Recent seasonal patterns of California avocado sales and prices are shown by the indexes in Figure 17. An index of 1.0 is the monthly average for the 1987 through 1995 calendar years.[22]

Figure 17. Seasonal Index of California Avocado Sales and Average Price, 1986-1995.



As shown, average monthly sales tend to be at or above average for the first eight months of the year (January through August), with peak sales usually occurring in May, and below average for the last four months, with the lowest average monthly sales in November. The general, although not perfect, inverse relationship between sales and prices are evident in Figure 17. The lowest average

[22] The index of seasonal sales of California avocados for the nine-year period 1987 through 1995 was calculated by (1) computing monthly sales for each calendar year, (2) dividing monthly sales by average sales for each calendar year to derive an index of monthly sales for that year, and (3) summing the indexes over the nine-year period and dividing by nine to derive an average monthly index. The seasonal price index was developed using the same steps.

prices typically occur in May, when sales are highest, and the highest average prices tend to be in October, when sales are low, but a month before they are the lowest. Note that the decreasing prices with decreasing sales between October and November are associated with a change in the varietal composition of sales. Sales of the Hass variety, which fetches the highest average prices, reach a seasonal low in November just as the sales of the other green skin varieties, which peak in December, are increasing. As noted earlier, the Hass variety now accounts for over 80 percent of California avocado production. Seasonally, the Hass price is highest in November when sales are lowest, and it tends to be lowest in May, when sales are at their seasonal peak. The inverse relationship between seasonal sales and the price of all other varieties is also evident. Their average price is lowest in December when sales tend to be highest. We hypothesize that there is also seasonal variation in the demand for avocados. It is important to incorporate these seasonal movements in the estimated demand relationship for avocados.

Monthly Demand Model Specification

The specification of a monthly demand model for avocados is similar to the specification of annual demand, but with minor modifications required to account for time-related differences and more detailed data. Thus, we begin by specifying the general monthly demand relationship:

$$Pc_t = f(Qc_t, Qf_t, Qm_t, A_t, BA_t, Y_t, P_{rt}, D_t, T_t) \qquad (11)$$

where for a specific month t, Pc_t represents the average f.o.b. price of California avocados, Qc_t is the corresponding per capita sales of California avocados, Qf_t is per capita sales of Florida avocados, Qm_t is per capita avocado imports, A_t is advertising expenditures by the California Avocado Commission, BA_t is brand advertising expenditures by California avocado packers, Y_t is per capita disposable income, and P_{rt} represents prices of related goods. The variable D_t, which was not present in the annual model, represents a row vector of monthly dummy variables, which allows the intercept of the inverse demand function to vary by month.[23] These monthly shift variables account for seasonal differences in demand not captured by the other explanatory variables, including such things as shifts in demand related to temperature or the availability of

[23] Monthly dummy variables equal one if the observation is for the designated month and zero otherwise.

related goods, differences in the number of days in some months, and possible changes in quality over the season. A time trend variable, T_t, was included to account for changing demand over time not captured by the other shift variables.

As in the annual analysis, all dollar-denominated variables are expressed in real terms using the consumer price index as a deflator. In addition, the quantity variables and income are given in per capita terms to account for the effect of population on demand. The advertising variable is expressed in real terms but is not adjusted for population growth.

Data Series

Table 6 defines and describes the key variables available to estimate equation (11). The core data set consists of nine crop years of monthly observations (108 total observations), beginning November, 1986 and extending through October, 1995. A listing of most of the data

Table 6. Definitions of Variables Used in Monthly Demand Model

Variable	Definition	Units	Mean Value	St Dev
Pc	monthly average FOB price for all California avocados, deflated by the consumer price index (1982-84=100)	real cents per pound	63.81	28.36
Qc	monthly shipments of all California avocados, divided by US population for the period	pounds per capita	0.0989	0.0435
Qf	monthly shipments of all Florida avocados, divided by US population during the period	pounds per capita	0.0139	0.0146
Qm	monthly shipments of all imported avocados, divided by US population during the period	pounds per capita	0.0089	0.0159
MA	a moving average of monthly CAC expenditures for advertising and promotion, deflated by the consumer price index (1982-84=100)	millions of real dollars	0.3112	0.1795
Y	US per capita disposable income, deflated by the consumer price index for all items (1982-84=100)	thousands of real dollars	12.729	0.2921
T	Monthly time trend variable that has a value of one for November 1986 and 108 for October 1995	month		

Notes: the core data set consists of 9 years of monthly observations beginning November, 1986 and extending through October, 1995 (108 total observations).

utilized for the monthly analysis is included as Appendix Tables 7 through 9.[24] As shown in Appendix Table 9, price indexes for goods thought to be related to avocados were available. However, initial investigation and subsequent testing, showed these price indexes had little or no explanatory power in the avocado demand relationship; therefore, variables represented by Prt were dropped from the model. Initial investigation and testing of the brand advertising variable BA_t also revealed that it added no explanatory power in the avocado demand relationship and it was deleted from the model. The time trend variable, T_t, was deleted for the same reason.

The Advertising Variable

Marketing expenditures by the California Avocado Commission were available by seven categories for the period November 1985 through October 1995. The categories and their shares of total expenditures are: consumer advertising, (41.6%); consumer promotion, (9.6%); trade advertising and promotion, (24.8%); foodservice, (11.8%); public relations, (6.7%); international promotion, (4.2%); and processed products, (1.3%).[25] Attempts to isolate the separate effects of the seven different types of expenditures yielded disappointing results. Initial analysis using all seven categories yielded statistically insignificant coefficients for several categories. This led us to group the seven categories into various sub-categories for further analysis. While the estimated coefficients for consumer advertising and consumer promotion were always positive and generally statistically significant at high confidence levels, the estimated coefficients for the other categories were not. In fact, the variation in signs and magnitudes of the estimated coefficients from formulation-to-formulation indicated the possible presence of statistical problems with the separate categories.[26] Given the overall objectives of this study and our lack of confidence in estimates for separate categories of marketing expenditures, we aggregated the seven categories into a single variable for advertising and promotion.

[24] Confidential data on monthly CAC marketing expenditures by category are available directly from the Commission.

[25] These percentages differ slightly from those noted with Figure 14 due to an additional year's data.

[26] Some possible problems include multicollinearity, errors in classifying expenditures, and differing lag structures for the separate categories.

It is reasonable to expect the effects of advertising and promotion to extend over several weeks or months and this dynamic response should be included in the regression model. The challenge is to determine the relevant duration and the nature of these lagged effects. We expect the carryover effect of avocado advertising to be less than 12 months, given other research results.[27] Because the precise nature and duration of the lagged effect is difficult to determine, our strategy was to do initial model estimation and testing with a simple, moving-average lag structure and then expand the analysis of lagged advertising effects after developing a basic model. To that end, a number of moving average processes were considered. Of the alternatives , a three-month moving average, defined as:

$$MA3t = (A_{t-1} + A_{t-2} + A_{t-3})/3,$$

appeared to perform well. Moreover, the lag length implied by MA3t is consistent with related prior work (e.g., Kinnucan and Forker, 1986; Alston, Chalfant, Christian, Meng and Piggott, 1996). This lag structure was therefore used to represent advertising effects in our initial model development and testing. The appropriate lag structure is an empirical problem. Thus, after determining the variables to include in the final monthly price equation, we investigated a variety of polynomial lag structures of up to 8 months as a replacement for MA3.

Model Estimation and Testing

In the annual model, we argued that crop-year-total avocado quantities were predetermined by prior-period production decisions and events, such as weather, that were independent of the current-period price. Thus, single-equation estimation methods were appropriate. For the monthly analysis, however, it is more likely that prices and sales are determined simultaneously, since producers may be able to exercise some month-to-month control over harvest and shipment timing, depending on prices. If this is the case, a simultaneous equation system technique, accounting for a market process in which prices and quantities are determined jointly through the simultaneous interaction of supply and demand functions, is required for estimation of monthly demand.

[27] These studies by Clarke (1976), Reynolds, McFaul and Goddard (1991), Kinnucan and Forker (1986), and Ward and Dixon (1989) were reviewed earlier. Recall that the annual analysis of avocado demand examined possible advertising lag effects of one and two years, but found that neither was statistically significant.

Simultaneity of Supply and Demand

The hypothesis that avocado quantities are exogenous in equation (1) was examined by means of the Hausman test. To conduct the test, a set of instrumental variables was identified and assembled, consisting of the following:[28] (1) all of the assumed exogenous variables in the demand equation, including the monthly dummy variables; (2) variables indicating the total quantities of California and Florida avocados produced in the (respective) crop year corresponding to each monthly observation;[29] and (3) lagged values of all endogenous and exogenous variables. The number of potential instrumental variables identified is quite large, since lags of different lengths might be considered. The set was narrowed by regressing each quantity variable on a number of potential instruments, and selecting those with the greatest explanatory power. (In general, a linear combination of good instrumental variables should be highly correlated with the possible endogenous factors.)

Using different numbers and combinations of instruments, and different functional forms for f( ), the Hausman test clearly rejected the hypothesis that Qc is exogenous. This result suggests that California avocado growers do respond to price in the timing of their harvests and shipments, and the effects show up in data reported on a monthly basis. The results of Hausman tests were somewhat ambiguous concerning the quantity variables for Florida and imports (Qf and Qm), depending on the test specification. Nevertheless, the majority of the tests rejected exogeniety of both Qf and Qm and we therefore conclude that all quantity variables should be treated as endogenous.

Statistical Diagnostics and Tests

The presence of endogenous explanatory variables, which requires the use of simultaneous estimation techniques, substantially complicates the analysis. For instance, their presence means that it is not possible to obtain completely unbiased estimates of equation (11). It is important to note that the techniques used to estimate and test the model yield approximate results for finite

[28] In brief, instrumental variables are variables that are known (or believed) to be exogenous, yet are correlated with the potentially endogenous variables (see, for example, Kennedy, 1992, pp. 136, 159 and 169).

[29] These are valid instrumental variables since crop-year-total quantities are assumed to be predetermined.

sample sizes, with the accuracy of the approximation increasing with the size of the sample. Therefore, our strategy was to estimate equation (11) in a number of different ways and report those results that appear plausible. We are fortunate that having monthly data provides a relatively large sample.

Equation (11) was estimated with an instrumental variables (IV) method, which gives consistent (i.e., tending toward the true value as the sample size gets larger) parameter estimates. Because functional form tests, such as the Box-Cox described in the annual analysis, are difficult to implement with an IV estimation method, we considered four distinct functional forms: (a) linear, (b) log-linear, (c) semi-log (i.e., only the dependent variable transformed), and (d) a Box-Cox transformation of the dependent variable, using $\lambda = -0.23$, as estimated for the annual model.

An important consideration with the IV estimation method concerns the number and set of instruments to use. In general, the set of instruments chosen defines a tradeoff between (finite-sample) bias and efficiency --- a larger number of instruments yields more efficient estimates (i.e., estimates with a smaller variance), but also yields estimates that are more biased. In consideration of this fact, all IV regressions and tests were performed with at least two different sets of instruments, one with more instrumental variables and one with fewer, for comparison. A large discrepancy between estimates from the two regressions would suggest that the model may have poor finite-sample properties.

The initial IV regression models were tested for serial correlation and heteroskedasticity with the methods described in Davidson and MacKinnon (pp. 369-71 and 560-64, respectively).[30] Results were as follows for each functional form considered:

(a) Linear Model:	no serial correlation
	significant heteroskedasticity
(b) Log-linear Model:	significant AR(1) errors
	no heteroskedasticity

[30] Tests were performed for AR(1), AR(2), AR(3), and similar moving average, error processes.

(c) Semi-log Model: no serial correlation

significant heteroskedasticity

(d) Box-Cox Model: no serial correlation

significant heteroskedasticity

Because each model tested positive for one problem or the other, final estimates were obtained with a generalized method of moments technique, a variation on the IV method which is able to account for the indicated problems with the error terms. In the case of heteroskedasticity, White's heteroskedasticity-consistent covariance matrix estimator was used to correct for heteroskedasticity (Davidson and MacKinnon, Chapter 17).

The models were initially estimated with three quantity variables, Qc, Qf and Qm. The estimated coefficient for imports was always much larger than the coefficients for California and Florida quantity. We then tested restrictions on the quantity variables using a method analogous to the standard likelihood ratio test, as described by Newey and West (1987). The hypothesis, Ho: Qc = Qf = Qm, was clearly rejected and the hypothesis, Ho: Qc = Qf, was not rejected. Based on these tests, the final regressions were estimated with two quantity variables, Q = Qc + Qf and Qm.

Estimation Results

Inverse monthly demand equations were estimated using each of the specifications discussed above. While the linear and semi-log specifications each provided reasonable parameter values and correct signs, the linear model results were statistically superior. Results for the log-linear model were clearly inadequate on at least two counts: first, a number of estimated parameter values were implausible, with theoretically incorrect signs; and second, the model was rejected by the J-test of overidentifying restrictions, a test of general model specification for IV regressions.[31] The Box-Cox model results were very similar to those of the semi-log model.

The final step in estimating the demand function was to determine the appropriate lag structure for the advertising variable. The method used to select the lag structure and formulate the advertising variable follows:

[31] The J-test statistic is distributed as a Chi-squared, with degrees of freedom equal to the number of overidentifying restrictions.

1. The model was estimated with every combination of polynomial lags of degrees 2, 3 and 4 for lags extending up to eight months. It was clear from the results that longer lags were not appropriate.
2. For each estimated model, a single weighted-moving-average advertising variable was constructed, with the weights derived from the estimated coefficients (normalized to sum to one).
3. The model was then re-estimated using each of the moving average variables constructed in step 2. The J-statistic for each equation was used as the criterion for selecting the lag length. The J-statistic is (1/n) times the optimal value of the criterion function that is minimized to derive the GMM estimates. It is therefore analogous to SSE and can be used to compare equations as long as everything is the same except for the weights used to form the advertising variable. For the equations estimated, the J-statistic was minimized with a 2nd degree polynomial and a lag length of five months. The weights used to construct the advertising variable were as follows:

Month Lag	MA5 Weights
0	.0000
1	.0274
2	.2133
3	.2996
4	.2863
5	.1734

Estimation Results

The estimated monthly inverse demand equation for California avocados using the above weights for the advertising variable is reported in Table 7. The signs on the coefficients are as expected and most are statistically significant. Since our emphasis is on evaluation of the impact of advertising and promotion, we are particularly interested in the estimated advertising coefficient.

Table 7. Estimation Results for Monthly California Avocado (Inverse) Demand Model

Variable	Coefficients
Q-CA+FL	-872.17*
	(-10.42)
Q-Imports	-1,776.9*
	(-5.16)
MA5	21.19*
	(2.07)
Y	2.56
	(0.28)
MD2	-17.65*
MD3	-6.51
MD4	-0.37
MD5	0.28
MD6	8.07
MD7	24.65*
MD8	30.99*
MD9	43.93*
MD10	61.77*
MD11	26.65*
MD12	6.45
Constant	122.51
J-Test	0.78
(Overidentifying Restrictions)	(3)

Notes: Numbers in parentheses are asymptotic t ratios. To reduce notational clutter, t ratios are not shown for the coefficients associated with the dummy variables and the constant term—asterisks indicate those coefficients that are significant at the 5% level or better.

Note that the advertising coefficient is statistically significant at the 95% level.[32] The linear form of the equation implies the existence of constant returns to advertising; an alternative formulation using

[32] An equation using a three-month lagged advertising variable was not selected because of a higher J-Test value (1.03), but the coefficient on the advertising coefficient was significant at the 2% level.

the square root of the advertising variable provided similar results but the estimated coefficient was not significant at the 95% level. The estimated price flexibility of advertising at mean values is 0.137, a value that is very close to the earlier annual estimate of 0.13. This result verifies and strengthens the results from the annual analysis of demand. We conclude that CAC advertising expenditures have increased the demand (and prices) for California avocados.

There is a strong and statistically significant inverse relationship between monthly sales of domestically produced avocados (California plus Florida) and the real f.o.b. price of California avocados. Imported avocados substitute for California avocados on a monthly basis, with increased import sales having a negative impact on the price of California avocados. Note that for equivalent amounts, the impact of imports is about twice as large as is the impact of domestic avocados. The estimated monthly price flexibilities evaluated at the data means are; California and Florida quantity, -1.54; and imports, -0.25.[33] There is also a positive but statistically insignificantrelationship between per capita income and the price of California avocados. This lack of significance is not too surprising given the short time period and the small variation in income.

The monthly dummy variables isolate seasonal changes in demand (and prices) after accounting for seasonal patterns of production, imports, and advertising. All of the estimated coefficients measure real price differences from the base of November (the first month of the marketing year). Those coefficients that are significantly different than zero at the 95 percent confidence level include December (MD2), and the five months from May through September (MD7 through MD11). The pattern of monthly shifts in demand is illustrated in Figure 18. As shown, demand for California avocados is at the seasonal low in December. It then increases rather smoothly to a seasonal high in August and then decreases to the end of the crop year.

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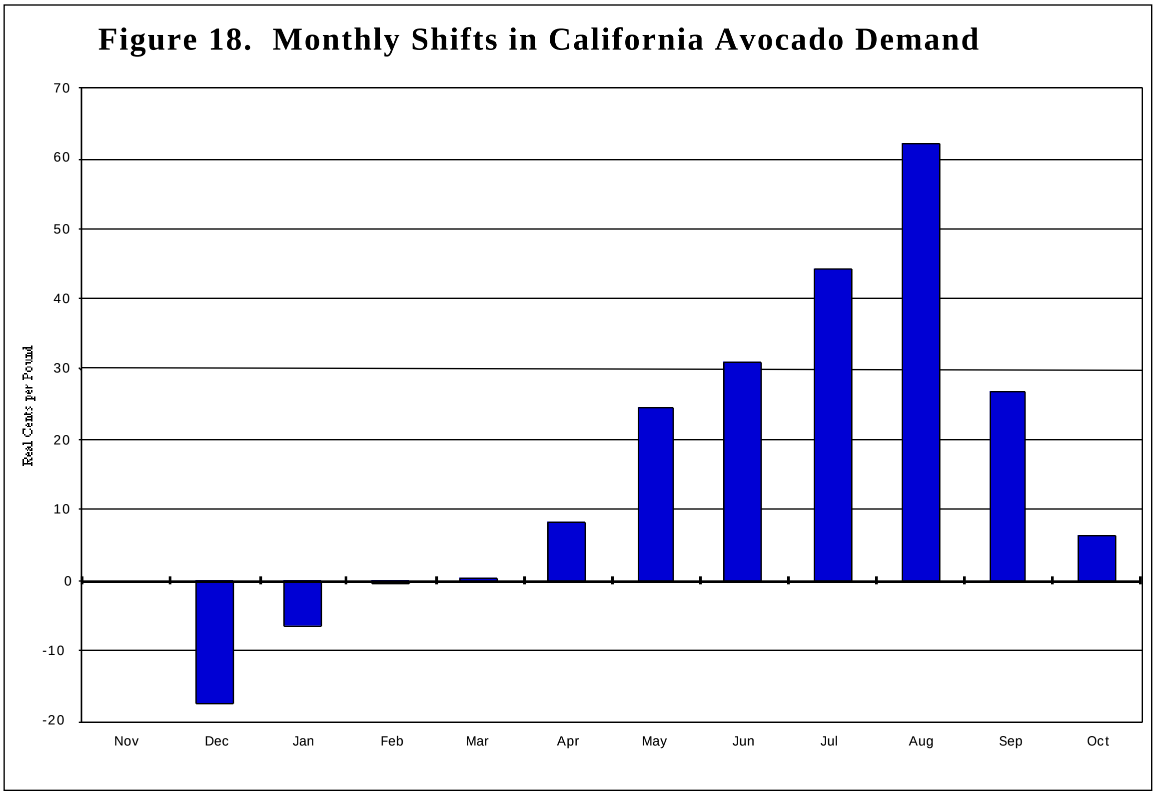
[33] The comparable annual estimates from prior work were California quantity, -1.33; Florida quantity, 0.06; and imports, -0.10.



Analysis of Advertising Benefits and Costs

There are several approaches available for measuring estimated benefits and costs of the California avocado industry's advertising programs given the demand and acreage response equations developed in this study. Using either the annual or the monthly demand equations, one can develop short-run (within year) estimates of the benefits of increased demand due to advertising. These estimated annual or monthly benefits are then divided by actual annual or monthly costs to calculate average benefit-cost ratios. A ratio greater than one indicates that total returns from advertising were greater than the costs; the higher the ratio, the higher are the returns from advertising. A positive benefit-cost ratio less than one indicates that advertising increased revenues but the increase was less than the costs.

The short-run benefit-cost ratios based solely on estimated demand do not account for the lagged supply response to short-run price improvements and thus, they tend to overstate the benefits from an advertising program conducted over a long period of time. We combine the acreage response and annual demand equations to form a recursive model of supply response and use this model to simulate annual total revenues over time both with and without the advertising program. The differences in total crop revenues measure advertising benefits which are then compared with annual program costs.

The short-run and longer-run benefit-cost ratios outlined above are averages of benefits and costs. The marginal response of revenues to additional advertising is also of interest since it indicates whether the industry had over- or under-allocated funds to advertising. We will examine marginal benefit-cost ratios by increasing annual or monthly advertising expenditures by one percent and calculating the ratio of the change in benefits to the change in expenditures.

Analytical Model of Supply and Demand

The measurement of returns from advertising can be illustrated with the hypothetical supply and demand relationships shown in Figure 19. The annual demand curve for avocados without advertising is shown by the demand curve D. With an effective advertising program, the demand curve D will increase (shift to the right) to D^A. Since avocado supply is essentially fixed for a given marketing year, as represented by the vertical supply curve S, average prices increase from P_0 to P_1 . Increased revenues (and profits) will encourage producers to expand acreage and, after a lag of several years, production. The lagged increase in production is shown by the outward shift of a fixed annual supply from S to S^A . Because of significant delays between the time a decision to expand production is made and actual output is available, higher prices to producers will persist during the early years of the advertising program. Then, as new trees reach bearing age, expanded production will shift the vertical supply curve to the right and prices will decrease from P_1 to P_2 , as shown in the diagram. As illustrated, total revenue with advertising (the rectangle 0 P_2 c Q_2) is greater than total revenue without advertising (the rectangle 0 P_0 a Q_1).

In this study, the short-run monthly or annual returns from advertising are measured by the rectangle P_0 P_1 b a. The longer run returns from advertising, which account for for the effects of supply response, are measured by the difference between total revenue with advertising and total

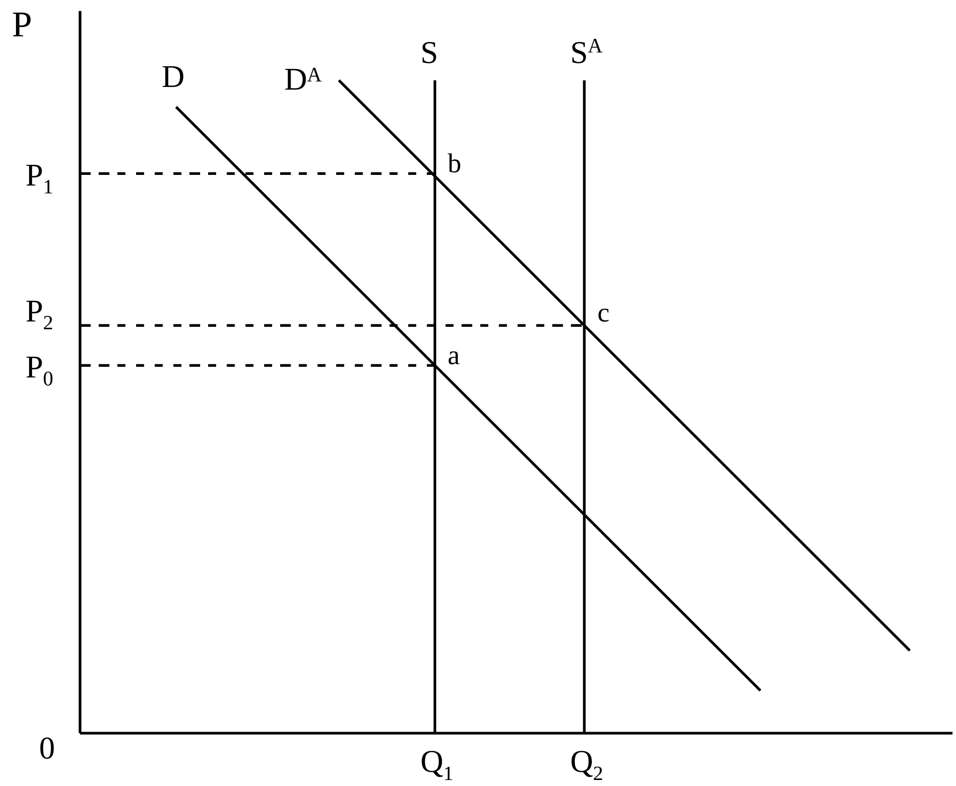


Figure 19. An Economic Model of Avocado Supply and Demand.

revenue without advertising. The returns from advertising must be compared to the costs of advertising to evaluate the profitability of the program. There are two possible measures of costs. The obvious measure is the total dollars spent on advertising, which implicitly assumes that avocado producers bear all of the costs of the program. However, when the advertising cost is financed by a percentage assessment on total crop revenues at the producer level, some of the incidence of the assessment, over time, will fall on buyers through the operation of supply and demand. A second measure of costs allows some of the costs to be borne by buyers, resulting in the producers' share of costs being less than actual expenditures.

Figure 20 shows the same short-run supply (S) and demand curves D and D^A as in Figure 19. As noted, the vertical supply curve, representing a fixed supply for a given marketing year, will shift annually due to the lagged effects of new plantings and current removals. The long-run supply curve can be approximated at any point in time by drawing a line from the initial price-quantity equilibrium through the new price-quantity equilibrium. This is illustrated in the figure by the line LRS connecting the initial equilibrium at point a with a new equilbrium on the demand curve D^A at point c. The function LRS, however, does not include the producer assessment, which when introduced, shifts the supply function back to LRS', resulting in a higher price for buyers (P_3), a lower net price to producers, and a smaller quantity produced and consumed (Q_3).

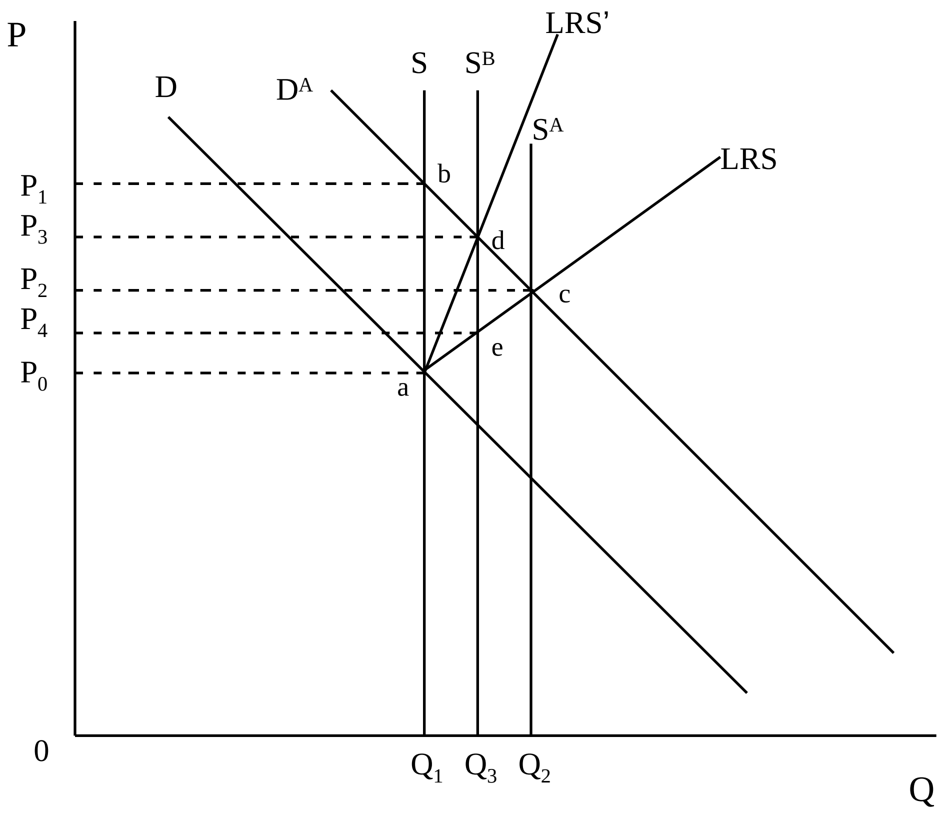


Figure 20. Long-run Avocado Supply and Demand With and Without Assessments

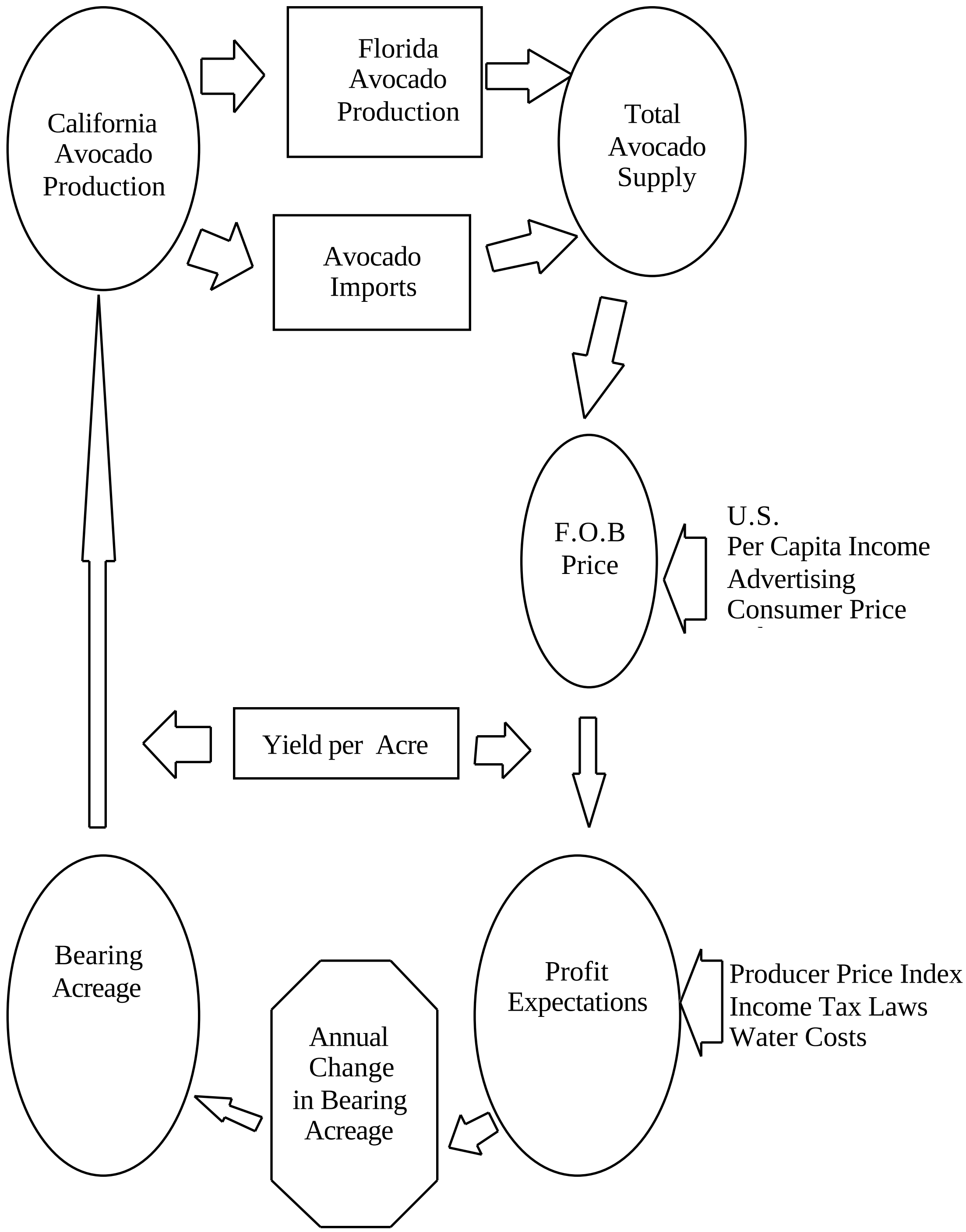
The amount of the price increase depends on the slopes of the supply and demand curves. When supply is fixed and unresponsive to price, as it is in the short run, there is no increase in the price to buyers and all of the costs are borne by producers. The more responsive quantity supplied is to price (the more price elastic is supply), the smaller will be the proportion of the assessment borne by producers. Our estimate of avocado producers' annual costs for the advertising program over the long run is the difference between total revenue before the assessment and total revenue after the assessment.

Avocado Supply Response

The price and change in bearing acreage equations estimated in the previous sections were combined into a recursive model of supply response. A diagram of the circular flow of calculated relationships in the model is shown in Figure 21. First, we entered initial values for lagged real total revenue and actual values for per capita disposable income, the consumer price index, the index of prices paid by farmers, population, average yield per acre, Florida avocado production, quantity of avocado imports, and advertising expenditures. Starting with these values, the model generated values for annual bearing acreage, average price per pound, and total revenue per acre for California avocados. As illustrated in Figure 21, bearing acreage multiplied by average yield determine California production. Total production is combined with demand factors to calculate the average price of avocados. The year-to-year change in bearing acreage was a function of profit expectations, which were based on lagged per acre total revenue (price multiplied by average yield) adjusted by the index of prices paid by farmers, and on avocado prices and the producer cost index lagged one year.

A comparison of actual and simulated values for bearing acreage is presented in Figure 22. The actual peak bearing acreage was 76,307 in 1987 while the simulated peak was almost identical at 76,289 acres, but it occurred two years earlier in 1985. While the actual and simulated peak acreage are very close, the simulation model typically underestimated or overestimated acreage during much of the period with the largest overestimated acreage being 5,260 acres in 1980 and the

Figure 21. A Recursive Simulation Model of California Acreage, Production and Prices.



largest underestimated acreage being 1,903 acres in 1993. The average annual absolute difference between actual and simulated acreage was 1,390 acres (3.6 percent). Overall, the model did a very good job of tracing the total bearing acreage adjustments that occurred during the 1962 through 1995 period, with the difference in actual and simulated 1995 acreage being only 187 acres.[34]

To derive long-run estimates of the impact of advertising on production and prices of California avocados over time, the simulation model was run with zero advertising expenditures.

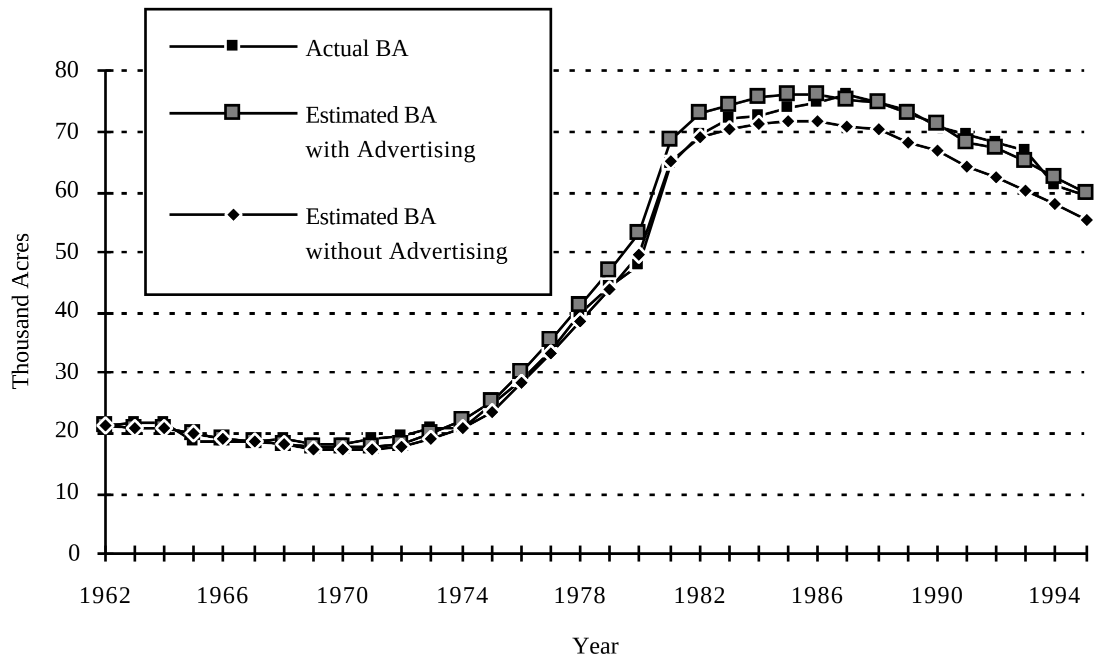


Figure 22. California Avocado Bearing Acreage, Actual and Simulated with and without Advertising, 1962-95

Comparison of the simulated advertising and no advertising scenarios shows that advertising increased prices and per acre returns and that these improved returns led to expansion of bearing acreage and production. Simulated bearing acreage reaches a peak of 76,289 acres in 1985 with advertising and 71,819 acres during the same year without advertising (Appendix Table 10). As

[34] It is not unusual for models that simulate cumulative values of a parameter to diverge significantly from actual values as the number of periods increase. This model performed much better than is usual for the time period covered.

shown in Figure 22, the last observation of bearing acreage with zero advertising is 55,196 acres, 4,568 acres (almost 8%) less than with advertising.

Price Elasticity of Supply for California Avocados

The long-run supply curve for avocados is an important component for estimating benefit-cost ratios for advertising,but defining the long-run supply curve is difficult because of the extensive lagged relationships between production and prices. The long-run industry supply curve shows the production or output (number of units) that will be placed on the market at all alternative prices, other factors equal. In the case of avocados, the supply response to a price change varies by year. This is illustrated in Figure 23 for two scenarios, a one-time, one-shot increase of 10 percent in average annual avocado prices in year zero, and a continuous increase of 10 percent in average

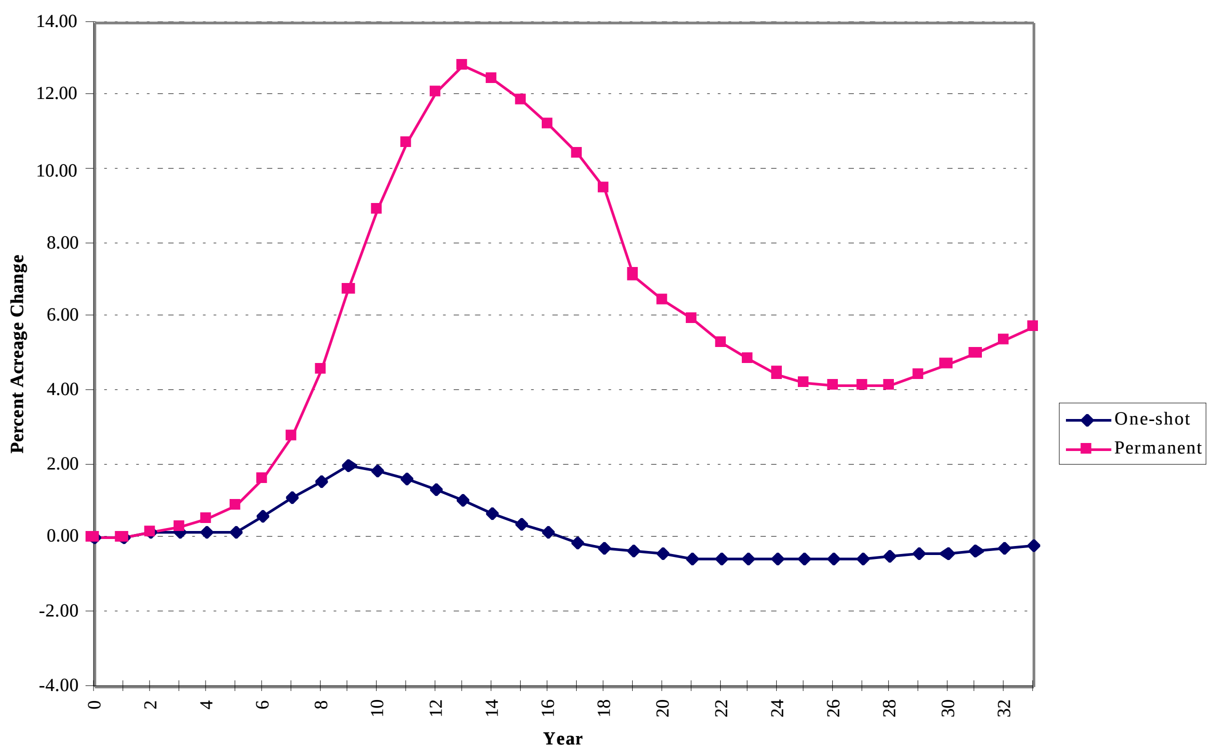


Figure 23. Estimated California Avocado Acreage Response to 10 Percent Price Increase: One Shot in Year Zero and Permanent.

annual prices. As shown by the lower line, the supply response to a one time 10 percent price increase varies by year over time. There is no change in the quantity supplied until year 3, the maximum response is approximately two percent in year 9, and the effect is negative after year 17 as a result of reduced prices when production was increasing. The supply response to a continual (permanent) 10 percent price increase is much larger. The maximum response of approximately 13 percent occurs in year 13 and then the percentage change in output decreases to about 4 percent in years 26 to 28 before again increasing. The maximum estimate of price elasticity of supply, which will vary by the year selected, is equal to 1.3.

Annual Short-Run Benefit-Cost Ratios for Advertising

The estimated annual demand relationship is used to estimate benefits from advertising in a year-to-year (short-run or fixed supply) framework by calculating price and total revenue for actual production each year both with and without advertising. Given the positive coefficient for the advertising variable in the estimated demand equation, increased advertising results in higher average prices during a given crop year, other factors equal. The short-run comparison of annual estimated prices with and without advertising indicated that advertising yielded positive net returns (the benefit/cost ratio was greater than one) for all crop years beginning with 1965-66 (Appendix Table 11a). The short-run total benefit/cost ratio for advertising ranged from 0.76 to 0.93 during the first four years of the program (1961-62 through 1964-65) and then ranged from 1.32 to 14.37 during the remaining period of analysis, with a weighted annual average of 7.09 for the total period (Figure 22). Thus, each dollar spent on advertising increased average total sales revenue in the same year by $7.09, and after subtracting the cost of advertising, yielded a net return of $6.09.

Readers will note that some of the largest returns are observed during the most recent eight years of the CAC advertising program. Since the costs and benefits of the advertising program change from year to year and accrue over time, when calculating returns it is more meaningful to account for changing price relationships and discount the stream of costs and benefits. Thus, the current costs and returns from advertising are restated in 1994-95 dollars in Appendix Table 11a, and these are used to calculate the present value of the program at discount rates of 0 and 3 percent.

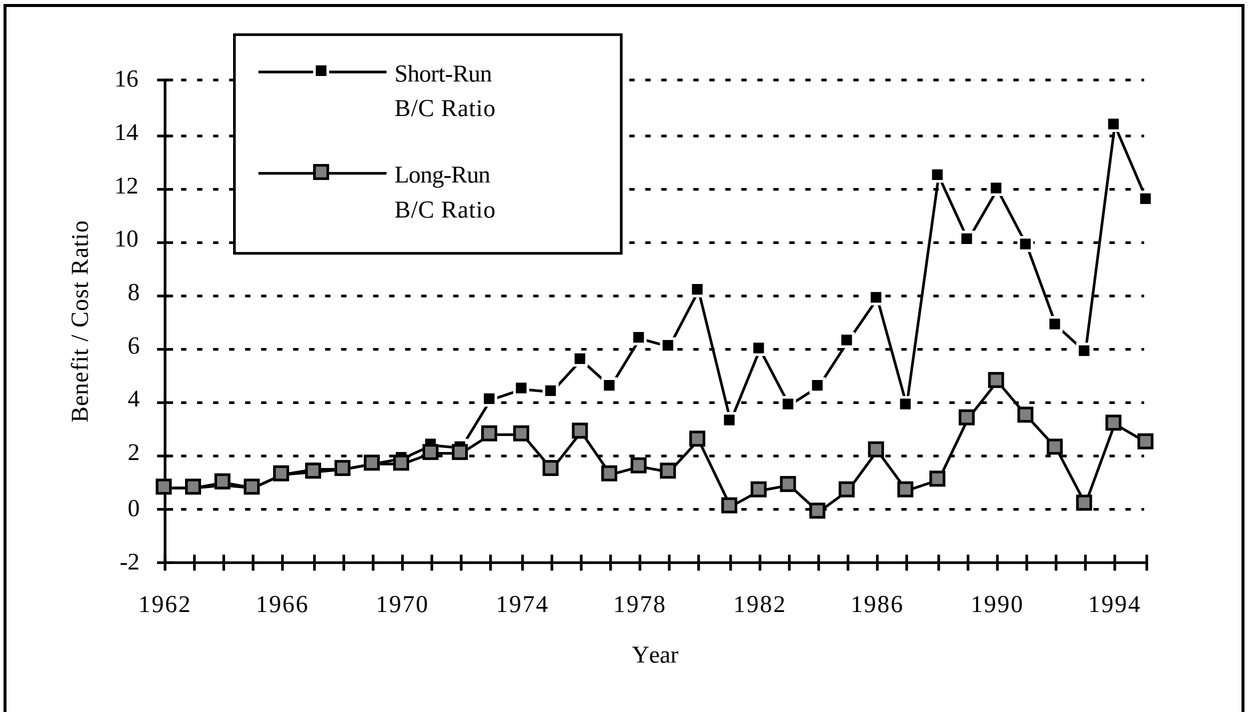


Figure 24. Estimated Short-run and Long-run Benefit-Cost Ratios, 1961-62 through 1994-95 Crop Years.

Note that the annual benefit-cost ratio is the same in current or 1994-95 dollars. When advertising costs and returns are discounted at 0 and 3 percent, the benefit-cost ratios are 6.01 and 5.33, respectively.

This fixed supply analysis does not fully account for the supply response that *could* occur over time, which may limit the applicability of the weighted average based on summation across the years presented above. The acreages used were those actually occurring with advertising, but if advertising had been eliminated in 1975, 1985, or any other year, subsequent with-and-without advertising quantities would have changed. A simple average of the annual fixed supply benefit-cost ratios avoids the problems of adding up over time. This average, which is equal to 5.25, is close to the estimated aggregate short-term returns from advertising discounted at 3 percent (B/C = 5.33).

Monthly Short-Run Benefit-Cost Ratios for Advertising

Short-run (fixed supply) benefits can also be estimated using the monthly demand relationship. Again, we calculate the difference in monthly price and total revenue due to advertising for actual monthly sales. Given the positive coefficient on advertising in the estimated demand equation, we know that advertising expenditures increase average prices during a given month, other factors equal. Following the pattern used for the annual demand equation, we calculated total monthly benefits and costs associated with CAC marketing expenditures for the nine crop years 1986-87 through 1994-95 on both a current and discounted basis. In current terms, the total increase in revenues due to advertising and promotion for the nine-year period was just over $337 million. Total CAC marketing expenditures during the same time period were just over $59 million. Thus, aggregated benefits and costs yield a benefit/cost ratio of 5.71 for all CAC marketing expenditures during the most recent nine years.

To provide a basis of comparison with the annual analysis, the aggregated monthly costs and returns from advertising are restated in October 1995 dollars and these are used to calculate the present value of the program at discount rates of 0 and 3 percent. The benefit-cost ratios for all CAC marketing expenditures over the 1986-87 through 1994-95 crop years, when costs and returns are discounted at 0 and 3 percent, are 5.74 and 6.35, respectively. Note that these discounted net returns are close to those estimated for the 1961-62 through 1994-95 crop years using the annual demand equation.

Because of the linear nature of advertising response in the monthly demand equation, the simple average of the monthly benefit-cost ratios and the simple average of monthly marginal benefit-cost ratios is equal.[35] For the nine-year period of analysis, the monthly marginal and average benefit-cost ratios are equal to 8.92. The marginal benefit-cost ratios were greater than one

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[35] Alston, et al. (1998) derive a simple formula for approximating the benefits from a marginal increase in promotional expenditures. The formula, derived from the commodity demand function, is: $\mu = Q \frac{\partial P}{\partial a}$ where μ is the marginal benefit, P is the product price and a is the advertising expenditure.

for all but two months of the period, indicating that the CAC could have profitably increased advertising and promotion during all but two months of the nine-year period.

Long-Run Benefit-Cost Ratios for Advertising

As documented in the acreage response analysis, producers expand acreage and production when returns are favorable and improved returns from advertising expanded the acreage and supply of avocados. The short-run net returns from advertising, described above, were eroded over time by increased supplies stimulated by the earlier increased returns. Given flexible prices (inelastic demand), the increased production from more acres of avocado trees partially offsets the demand-enhancing effects of advertising. As illustrated in Figure 24, the long-run benefit-cost ratio was again less than 1.0 during the first four years of the program; then the ratio exceeded one from 1965-66 through 1979-80; the ratio then dropped below 1.0 for the next five years and was even negative one year. The estimated benefit-cost ratio was greater than 1.0 in 1985-86, and for 7 of 9 years after that. The average benefit-cost ratio for the 34-years of the analysis was 1.89; the estimated increase in total industry revenue was $218.8 million and CAC marketing expenditures were $116.0 million. The long-run benefit-cost ratios, when costs and returns are discounted at 0 and 3 percent, are 1.78 and 1.71, respectively (Appendix Table 11b). A simple average of marginal benefit-cost ratios for the same period, derived by increasing advertising one percent during each year, is equal to 1.48. The marginal ratios tended to be less than one at the beginning of the period and greater than one at the end. For example, the average marginal benefit-cost ratio for the first 10 years of the analysis was 0.47 while the average for the last 10 years was 3.23.

Just as increased demand stimulated increased production of avocados over time, industry assessments tended to decrease supply. The long run impact of the adjustment to assessments for advertising is to shift a portion of the costs to buyers. Thus, long-run benefit-cost ratios estimated above tend to overstate the true costs of the program to producers. As noted earlier, we compute an estimate of the producers' share of costs by subtracting total producer revenue after the assessment from total producer revenue before the assessment. The results of this calculation are shown by year in Appendix Table 11c. The annual average benefit-cost ratio for the 34-years of the analysis was 2.84. The long-run benefit-cost ratios, when costs and returns are discounted at 0 and 3 percent, are 2.48 and 2.26, respectively.

A Projection of Long-Run Benefit-Cost Ratios for Advertising

A reviewer correctly noted that the long-run benefit/cost ratios just presented do not account for all costs and benefits stemming from the most recent advertising and promotion expenditures. Because of the extensive lagged relationships found in the avocado industry, it is not clear if future adjustments will tend to increase of decrease estimated benefit/cost ratios. To obtain a measure of the future effects of recent actions, we project industry total revenues both with and without advertising 20 years into the future.[36] Then benefit/cost ratios for producers paying all advertising costs and producers sharing advertising costs with buyers are calculated. As shown in Appendix Table 11d, the benefit/cost ratio when producers pay all of the advertising costs increases from a low of 2.06 in 1998 to 5.14 in 2015. The benefit/cost ratio when producers share the advertising costs with buyers increases from a low of 5.02 in 1998 to 7.45 in 2015. Both of these ratios are higher than recent averages, indicating that the ratios for the study period did have time to stabilize and that large future costs to recent program actions are not a significant problem. Overall, the estimated long-run benefit/cost ratios during the study period appear to be on the conservative side, whether the producers pay all costs or share costs with buyers.

Thus, returns for CAC advertising and promotion programs have been very attractive, regardless of one's perspective. On a short run, fixed supply, month-to-month and year-to-year basis, returns have typically averaged $5 to $6 for every $1 expended. These are the relevant returns to consider when making short-run decisions on CAC advertising and promotion program expenditures. Over time, the supply response resulting from increased returns erodes prices and returns. This is the nature of the short-run versus the long-run returns to advertising when the industry does not control supply and there is ease of entry and exit. But, even in the long run,

[36] Future industry developments depend, of course, on the assumptions used for the variables in the simulation model. For this projection we used recent values for advertising ($4.47 million annually), imports (.18685 pounds per capita), florida production (.1534 pounds per capita), consumer income (increased 1 percent annually), population (increased 1 percent annually), and average per acre yields (6418 pounds per acre).

producers grossed over $1.70 for every dollar spent on advertising and promotion since 1961-62. This, increased to something over $2.26 for the producers' share of advertising expenditures.

Concluding Comments

This report presents the results of research directed toward examination of the effects of CAC advertising and promotion programs on the demand (and price) for California avocados over the period from 1961-62 through 1994-95. Annual demand and supply response relationships were estimated, with generally good results as measured by standard statistical tests and concurrence with theoretical expectations. There were weaknesses with the estimated annual demand equation, however, that appeared to be due to the annual data utilized. The estimated coefficient for the quantity of Florida avocados, for example, was not significantly different from zero and it had an unexpected positive sign. As indicated, we believe that different marketing and crop years for California, Florida and imported avocados was an important shortcoming with the data. There were also indications of measurement problems with early advertising and promotion expenditures. We collected and analyzed monthly data for the most recent decade to gain additional information on the nature of the empirical demand relationship for California avocados. The results of the monthly analysis generally confirmed the annual analysis, but with improved statistical measures and tests. We found that the effects of California and Florida avocado sales on monthly California prices were essentially the same; we were also able to measure the effect of advertising and promotion with increased statistical precision. The similarity of estimated annual and monthly price flexibilities of demand makes us very confident that we have been able to accurately measure the important determinants of California avocado demand, and in particular, the effects of advertising and promotion expenditures.

We follow the tradition of empirical economic analyses by noting that more research remains to be done. We were not able, for example, to isolate the separate impacts of various types of advertising and promotion expenditures on the demand and price of California avocados. We believe that carefully designed market experiments are required to best assess the comparative impacts of various programs. We were also forced to assume that dollar expenditures are a good measure of advertising efforts; that a dollar spent on a given program at a given point in time had the same impact as a dollar spent on any other program at any other time. This measurement problem is common to many studies of commodity advertising that utilize secondary data. Monthly data on advertising expenditures were not necessarily matched with the month in which the advertising (or promotion) was communicated to the target audience. Future data collection must be aware of the need to match measures of advertising effort with the timing of program execution to derive improved estimates of the dynamic effects of advertising programs. Finally, readers are reminded that the study results are for a specified past time period, and that while most of the estimated supply and demand relationships can reasonably be expected to continue in the near future, any projections using these relationships must be regarded with caution.

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Appendix Table 1. California Avocado Acreage by Category, 1920-1995.

Year	Bearing Acres	Nonbearing Acres	Total Acres	Year	Bearing Acres	Nonbearing Acres	Total Acres
1920	280	235	515	1958	19,794	5,439	25,233
1921	310	289	599	1959	20,205	5,061	25,266
1922	350	380	730	1960	21,301	4,754	26,055
1923	400	520	920	1961	20,045	4,378	24,423
1924	450	809	1,259	1962	20,862	3,066	23,928
1925	490	1,382	1,872	1963	21,194	2,628	23,822
1926	560	1,789	2,349	1964	21,921	1,706	23,627
1927	690	2,437	3,127	1965	21,570	1,224	22,794
1928	860	3,599	4,459	1966	18,810	2,530	21,340
1929	1,210	4,888	6,098	1967	18,620	3,060	21,680
1930	1,830	6,069	7,899	1968	18,730	3,150	21,880
1931	2,310	6,550	8,860	1969	19,220	4,300	23,520
1932	3,040	8,572	11,612	1970	18,040	4,200	22,240
1933	4,217	9,000	13,217	1971	18,380	4,560	22,940
1934	5,609	9,196	14,805	1972	19,039	5,085	24,124
1935	7,307	7,993	15,300	1973	19,611	6,029	25,640
1936	8,622	6,304	14,926	1974	20,741	6,635	27,376
1937	10,179	4,097	14,276	1975	20,715	10,884	31,599
1938	11,226	3,240	14,466	1976	24,882	14,692	39,574
1939	11,471	2,667	14,138	1977	29,041	14,697	43,738
1940	11,930	2,541	14,471	1978	33,866	12,947	46,813
1941	12,132	2,636	14,768	1979	39,802	11,335	51,137
1942	12,285	2,863	15,148	1980	44,369	11,083	55,452
1943	12,399	2,995	15,394	1981	47,831	11,532	59,363
1944	12,756	2,490	15,246	1982	64,798	14,808	79,606
1945	13,077	2,812	15,889	1983	69,448	12,161	81,609
1946	13,403	2,884	16,287	1984	72,296	5,212	77,508
1947	13,565	3,478	17,043	1985	72,861	2,208	75,069
1948	12,765	4,443	17,208	1986	74,131	1,266	75,397
1949	11,855	6,254	18,109	1987	74,812	521	75,333
1950	11,292	7,131	18,423	1988	76,307	4,142	80,449
1951	12,008	8,464	20,472	1989	75,062	3,083	78,145
1952	12,579	9,108	21,687	1990	73,368	2,395	75,763
1953	13,566	9,135	22,701	1991	71,007	1,126	72,133
1954	15,040	8,023	23,063	1992	69,582	819	70,401
1955	16,292	6,709	23,001	1993	68,159	644	68,803
1956	18,036	5,127	23,163	1994	66,865	505	67,370
1957	19,119	5,348	24,467	1995	61,254	987	62,241

Source: Data from 1920 through 1955 are from California Crop and Livestock Reporting Service, Special Publication 261; data from 1956 through 1987 are from California Agricultural Statistics Service, annual issues; data from 1988 forward are from California Avocado Commission.

Appendix Table 2. California Avocado Acreage by County and Area, 1950-1990.

Counties	1950	1955	1960	1965	1970	1975	1980	1985	1990
San Diego	11,474	13,712	13,616	11,798	12,920	18,463	24,254	36,843	36,402
Mid-counties									
Los Angeles	2,837	2,754	2,610	2,010	1,260	517	986	615	602
Orange	2,417	2,617	2,842	1,424	910	1,136	2,065	1,675	1,471
Riverside	228	351	511	427	590	4,546	8,737	8,518	8,487
San Bernardino	71	87	179	120	110	151	136	126	220
Sub-total	5,553	5,809	6,142	3,981	2,870	6,350	11,924	10,934	10,780
North Counties									
Santa Barbara	748	1,446	1,646	2,281	2,770	4,369	6,210	7,730	8,029
San Luis Obispo	0	1	1	1	0	502	1,049	804	1,245
Ventura	1,171	2,179	2,927	2,720	3,460	8,557	13,681	16,596	16,459
Subtotal	1,919	3,626	4,574	5,002	6,230	13,428	20,940	25,130	25,733
San Joaquin Valley									
Fresno	2	2	7	39	180	261	382	418	312
Tulare	1	0	48	65	230	888	1,658	1,802	1,179
Kern	0	0	0	0	0	113	127	173	14
Subtotal	3	2	55	104	410	1,262	2,167	2,393	1,505
Other	16	14	36	11	180	71	78	97	118
TOTAL	18,965	23,163	24,423	20,896	22,610	39,574	59,363	75,397	74,538

Appendix Table 3. California Avocado Average Yields per Acre, 1925-1995.

Year	Ave Yield lbs/acre	Year	Ave Yield lbs/acre
1925	531	1961	3542
1926	821	1962	4793
1927	1797	1963	3775
1928	744	1964	4270
1929	1901	1965	2225
1930	437	1966	6167
1931	1861	1967	8002
1932	1711	1968	3994
1933	806	1969	6358
1934	891	1970	3659
1935	2546	1971	7291
1936	1206	1972	2731
1937	1218	1973	7180
1938	944	1974	5149
1939	2598	1975	10186
1940	1308	1976	4694
1941	2407	1977	8264
1942	3028	1978	6319
1943	2516	1979	6181
1944	3340	1980	3381
1945	1774	1981	9952
1946	3581	1982	4846
1947	2728	1983	5817
1948	2914	1984	6833
1949	2429	1985	5490
1950	2745	1986	4317
1951	3731	1987	7432
1952	4452	1988	4693
1953	3420	1989	4391
1954	2832	1990	2834
1955	5549	1991	3824
1956	2218	1992	4468
1957	1653	1993	8360
1958	4678	1994	4053
1959	5098	1995	4966
1960	6572		

Appendix Table 4. New California Avocado Plantings Reported the Year of Planting and Up to Eight Years Later, 1950-1992.

Year (t)	Avocado planting in year t that was standing in year								
	t	t+1	t+2	t+3	t+4	t+5	t+6	t+7	t+8
1950	706	848	878	2023	2063	2059	**2257**	2160	2044
1951	688	772	1691	1792	1714	1870	**1911**	1843	1868
1952	238	982	1436	1468	1642	**1838**	1641	1621	1522
1953	551	988	1026	1175	**1570**	1327	1375	1239	1201
1954	417	517	896	1175	**1228**	1212	1201	1181	1112
1955	399	737	1318	1435	**1454**	1426	1420	1381	1367
1956	897	1151	1322	1469	1493	1521	**1529**	1516	1496
1957	224	452	616	1119	1154	**1159**	1151	1130	1015
1958	621	1025	1037	1046	**1073**	1072	1026	946	946
1959	187	550	561	**719**	719	707	668	668	668
1960	178	192	392	391	392	404	**442**	428	428
1961	112	233	234	221	338	**349**	342	344	338
1962	209	246	247	429	**438**	419	420	380	370
1963	97	149	390	486	512	**533**	490	486	486
1964	155	461	546	**581**	578	575	573	573	573
1965	555	656	667	666	746	724	724	**787**	786
1966	702	853	871	906	913	924	1041	**1042**	1023
1967	453	504	1000	1000	978	1006	996	978	**1011**
1968	441	1024	1039	1053	1072	1036	1279	1458	**1495**
1969	498	532	617	672	725	638	830	**867**	864
1970	713	955	1222	1294	1211	1266	**1397**	1297	1331
1971	1344	1674	1753	1656	2219	2308	**2335**	2284	2290
1972	1234	1477	1665	2475	2632	**2671**	2611	2617	2648
1973	1386	2607	3632	3816	3780	3952	3944	3960	**5949**
1974	3745	5593	5764	5945	6373	6384	6415	**8467**	8333
1975	5078	4451	4398	5197	5255	5298	**8104**	7534	6669
1976	3782	3949	3921	3878	4036	6120	6284	**6652**	6588
1977	3197	2930	2996	3065	4962	5274	**5940**	5904	5884
1978	2971	3648	3689	5125	5616	**6063**	5925	5940	5930
1979	3629	3692	5345	5308	5421	5352	5386	**5560**	5462
1980	3636	4556	**4629**	4026	4033	4059	4198	4159	4108
1981	**4305**	3948	2974	2967	3039	3035	2886	2891	3028
1982	**2933**	1109	1107	1143	1202	1435	1465	1618	1619
1983	488	537	701	737	848	861	880	**924**	924
1984	109	293	287	360	368	420	449	454	**455**
1985	13	38	121	127	203	355	357	**431**	
1986	23	321	342	392	603	**621**	610		
1987	61	78	130	149	162	**204**			
1988	18	88	226	232	**247**				
1989	57	124	**130**	130					
1990	29	43	**60**						
1991	3	**55**							
1992	**1**								

Source: California Agricultural Statistics Service, California Fruit & Nut Acreage, Annual Issues.

Appendix Table 5. California Avocado Acreage by Category, Plantings and Removals, 1950-92.

Year	Planting	Bearing Acres	NonBearing Acres	Total Acres	Removals
1950-51	2257	12008	8464	20472	1042
1952	1911	12579	9108	21687	897
1953	1838	13566	9135	22701	1476
1954	1570	15040	8023	23063	1632
1955	1228	16292	6709	23001	1066
1956	1454	18036	5127	23163	150
1957	1529	19119	5348	24467	763
1958	1159	19794	5439	25233	1126
1959	1073	20205	5061	25266	284
1960	719	21301	4754	26055	2351
1961	442	20045	4378	24423	937
1962	349	20862	3066	23928	455
1963	438	21194	2628	23822	633
1964	533	21921	1706	23627	1362
1965	581	21574	1224	22798	2039
1966	787	18810	2530	21340	447
1967	1042	18620	3060	21680	842
1968	1011	18730	3150	21880	**-629**
1969	1495	19220	4300	23520	2775
1970	867	18040	4200	22240	167
1971	1397	18380	4560	22940	213
1972	2335	19039	5085	24124	819
1973	2671	19611	6029	25640	935
1974	5949	20741	6635	27376	1726
1975	8467	20715	10884	31599	492
1976	8104	24882	14692	39574	3940
1977	6652	29041	14697	43738	3577
1978	5940	33866	12947	46813	1616
1979	6063	39802	11335	51137	1748
1980	5560	44369	11083	55452	1649
1981	4629	47831	11532	59363	**-15614**
1982	4305	64798	14808	79606	2302
1983	2933	69448	12161	81609	7034
1984	924	72296	5212	77508	3363
1985	455	72861	2208	75069	127
1986	431	74131	1266	75397	495
1987	621	74812	521	75333	**-4495**
1988	204	76307	4142	80449	2508
1989	247	75062	3083	78145	2629
1990	130	73368	2395	75763	3760
1991	60	71007	1126	72133	1792
1992	55	69582	819	70401	1653
1993	1	68159	644	68803	1434

Source: Plantings are from Appendix Table 4; Bearing and Nonbearing acres are from CASS; Removals are calculated from the other series using the procedures described in the text.

Appendix Table 6. Data Used in Annual Avocado Demand Model.

Obs	Year	CPI (1982-84=100)	US Population (millions)	Per Capita Income ($1,000s)	California Price (cents/pound)	California Production (million pounds)
-8	1953	0.267	159.6	1.58	17.40	46.40
-7	1954	0.269	162.4	1.59	18.50	42.60
-6	1955	0.268	165.3	1.67	10.45	90.40
-5	1956	0.272	168.2	1.74	20.70	40.00
-4	1957	0.281	171.3	1.80	22.00	31.60
-3	1958	0.289	174.1	1.83	9.70	92.60
-2	1959	0.291	177.1	1.97	8.40	103.00
-1	1960	0.296	180.8	2.01	5.50	140.00
0	1961	0.299	183.7	2.06	14.00	71.00
1	1962	0.302	186.6	2.15	10.70	100.00
2	1963	0.306	189.3	2.23	13.40	80.00
3	1964	0.310	191.9	2.38	12.90	93.60
4	1965	0.315	194.3	2.54	26.00	48.00
5	1966	0.324	196.6	2.72	13.10	116.00
6	1967	0.334	198.8	2.88	10.10	149.00
7	1968	0.348	200.7	3.10	23.00	74.80
8	1969	0.367	202.7	3.30	15.00	122.20
9	1970	0.388	205.1	3.55	34.10	66.00
10	1971	0.405	207.7	3.81	18.80	134.00
11	1972	0.418	209.9	4.07	47.60	52.00
12	1973	0.444	211.9	4.55	27.30	140.80
13	1974	0.493	213.9	4.93	39.60	106.80
14	1975	0.538	216.0	5.37	23.80	211.00
15	1976	0.569	218.1	5.84	51.90	116.80
16	1977	0.606	220.3	6.36	29.70	240.00
17	1978	0.652	222.6	7.10	37.00	214.00
18	1979	0.726	225.1	7.86	34.60	246.00
19	1980	0.824	227.7	8.67	74.80	150.00
20	1981	0.909	230.0	9.57	17.90	476.00
21	1982	0.965	232.2	10.11	34.50	314.00
22	1983	0.996	234.3	10.76	23.00	404.00
23	1984	1.039	236.4	11.89	18.50	494.00
24	1985	1.076	238.5	12.59	29.10	400.00
25	1986	1.096	240.7	13.24	50.80	320.00
26	1987	1.136	242.8	13.85	16.90	556.00
27	1988	1.183	245.1	14.86	57.00	358.10
28	1989	1.240	247.4	15.74	62.80	329.60
29	1990	1.307	250.0	16.67	114.20	207.90
30	1991	1.362	252.7	17.19	71.20	271.50
31	1992	1.403	255.4	18.06	58.70	310.90
32	1993	1.445	258.2	18.55	20.70	569.80
33	1994	1.482	260.7	19.25	92.70	271.00
34	1995	1.524	263.1	20.17	74.70	304.20

Notes: CPI, population and income are reported on a calendar year; source: *The Economic Report of the President* and recent issues of *The Survey of Current Business*. California prices and production quantities are reported on a California crop year (year ending October 31 of stated year); source: California Agricultural Statistics Service.

Appendix Table 6 (Continued).

Obs	Year	CAC Marketing Expenditures (million $)	Florida Price (cents/pound)	Florida Production (million pounds)	Imports (million pounds)	Exports (million pounds)
-8	1953	0.00	5.50	19.14	6.92	.
-7	1954	0.00	4.90	23.32	8.28	.
-6	1955	0.00	5.10	25.96	7.40	.
-5	1956	0.00	5.10	28.98	5.34	.
-4	1957	0.00	5.60	21.23	6.61	.
-3	1958	0.00	4.80	27.66	5.72	.
-2	1959	0.00	6.30	8.14	7.07	.
-1	1960	0.00	4.00	15.51	8.77	.
0	1961	0.00	8.00	3.96	6.14	.
1	1962	0.18	7.70	13.40	0.17	.
2	1963	0.44	6.40	25.70	0.03	.
3	1964	0.51	6.40	30.60	0.01	.
4	1965	0.32	8.20	28.00	0.07	.
5	1966	0.79	20.40	6.20	0.25	.
6	1967	0.78	10.20	12.80	0.59	.
7	1968	0.58	8.50	32.30	0.37	.
8	1969	0.79	10.80	27.70	0.20	.
9	1970	0.76	13.10	30.80	0.80	.
10	1971	1.21	14.50	41.40	1.14	.
11	1972	1.10	16.90	42.50	2.26	.
12	1973	1.29	16.10	41.40	1.95	.
13	1974	1.55	17.80	40.60	2.25	.
14	1975	2.15	16.40	48.20	3.32	.
15	1976	2.15	20.00	63.80	2.94	.
16	1977	4.14	20.50	42.20	4.40	.
17	1978	3.60	34.50	21.40	6.97	.
18	1979	4.12	20.00	50.80	3.80	17.33
19	1980	2.72	29.90	54.60	3.11	17.98
20	1981	6.42	26.50	61.60	2.98	44.55
21	1982	3.19	25.10	51.60	1.68	17.83
22	1983	5.42	24.00	69.40	2.06	18.43
23	1984	3.47	23.00	54.00	4.13	28.28
24	1985	4.06	19.50	59.00	6.85	13.08
25	1986	5.18	28.80	57.00	11.42	12.11
26	1987	7.58	20.60	49.40	9.20	26.96
27	1988	3.36	15.60	58.00	5.41	29.39
28	1989	7.11	21.80	54.00	10.00	16.64
29	1990	6.33	16.60	67.00	25.98	10.06
30	1991	7.35	34.20	39.20	29.94	9.72
31	1992	8.63	23.80	56.60	51.88	14.76
32	1993	6.82	29.10	14.40	27.46	32.19
33	1994	5.10	41.00	8.80	39.41	19.87
34	1995	6.82	30.75	40.00	49.16	29.50

Notes: California producer marketing expenditures are reported on a California crop year (year ending October 31 of stated year); source: annual reports of California Avocado Commission and Advisory Board. Florida prices and production quantities are reported on a Florida crop year (year ending March 31 of stated year); source: USDA. Annual avocado imports are reported as follows: 1951-76, year ending June 30 of stated year; 1977-88, year ending September 30 of stated year; 1989-95, year ending October 31 of stated year; source: U.S. Bureau of the Census. Imports are reported for year ending October 31 of stated year; source: U.S. Bureau of the Census.

Appendix Table 7. Monthly Sales and Average F.O.B. Prices for California Avocados.

Year	Mo.	California Quantity Sold pounds	Ave. Ca fob Price cents/lb.	Year	Mo.	California Quantity Sold pounds	Ave. Ca fob Price cents/lb.	Year	Mo.	California Quantity Sold pounds	Ave. Ca fob Price cents/lb.
1984	11	.	.	1988	11	14,261,675	111	1992	11	9,765,125	72
1984	12	.	.	1988	12	21,646,825	68	1992	12	29,796,550	52
1985	1	.	.	1989	1	26,466,150	67	1993	1	29,999,375	53
1985	2	.	.	1989	2	24,169,100	67	1993	2	33,097,225	41
1985	3	.	.	1989	3	26,489,450	69	1993	3	45,231,200	35
1985	4	.	.	1989	4	25,954,025	67	1993	4	53,043,625	30
1985	5	.	.	1989	5	27,255,425	71	1993	5	46,445,925	28
1985	6	.	.	1989	6	19,063,375	85	1993	6	56,126,600	27
1985	7	.	.	1989	7	23,071,775	90	1993	7	50,041,825	29
1985	8	.	.	1989	8	18,808,225	89	1993	8	52,654,175	28
1985	9	.	.	1989	9	19,068,100	111	1993	9	36,741,000	46
1985	10	.	.	1989	10	14,883,725	128	1993	10	33,619,975	49
1985	11	.	.	1989	11	10,847,875	120	1993	11	25,716,900	72
1985	12	.	.	1989	12	17,456,950	102	1993	12	19,640,050	92
1986	1	.	.	1990	1	18,857,425	108	1994	1	24,332,325	91
1986	2	.	.	1990	2	16,076,675	105	1994	2	20,699,975	95
1986	3	.	.	1990	3	18,258,575	106	1994	3	24,922,325	101
1986	4	.	.	1990	4	17,741,625	135	1994	4	22,734,550	110
1986	5	.	.	1990	5	20,924,925	133	1994	5	23,904,300	114
1986	6	.	.	1990	6	18,517,400	156	1994	6	24,073,650	128
1986	7	.	.	1990	7	16,930,350	173	1994	7	21,221,875	135
1986	8	.	.	1990	8	14,993,625	173	1994	8	22,585,300	131
1986	9	.	.	1990	9	9,096,925	180	1994	9	13,891,500	136
1986	10	.	.	1990	10	5,539,200	181	1994	10	5,937,250	154
1986	11	22,362,800	43	1990	11	8,563,425	97	1994	11	4,970,625	129
1986	12	30,680,975	32	1990	12	18,007,350	84	1994	12	12,800,625	88
1987	1	30,216,625	32	1991	1	17,739,875	95	1995	1	19,388,100	122
1987	2	31,147,725	32	1991	2	17,703,125	92	1995	2	19,998,200	97
1987	3	37,366,225	32	1991	3	17,977,200	99	1995	3	25,551,825	92
1987	4	42,592,875	30	1991	4	23,677,975	95	1995	4	26,143,725	82
1987	5	43,720,925	27	1991	5	27,071,475	81	1995	5	31,796,875	74
1987	6	46,094,550	27	1991	6	22,899,850	92	1995	6	29,450,075	87
1987	7	44,927,700	26	1991	7	25,948,375	84	1995	7	29,761,100	83
1987	8	43,647,525	23	1991	8	25,059,475	75	1995	8	32,981,500	73
1987	9	41,650,725	24	1991	9	17,814,200	118	1995	9	21,466,200	118
1987	10	39,864,025	28	1991	10	9,677,250	121	1995	10	14,688,950	130
1987	11	30,343,150	42	1991	11	3,131,925	121	1995	11	7,492,000	116
1987	12	33,869,350	38	1991	12	12,398,100	100	1995	12	19,977,450	102
1988	1	26,293,900	47	1992	1	25,475,225	76	1996	1	28,444,025	85
1988	2	26,134,375	56	1992	2	21,803,950	69	1996	2	26,194,025	71
1988	3	27,361,775	65	1992	3	27,299,675	73	1996	3	29,788,075	73
1988	4	25,791,050	72	1992	4	33,337,525	59	1996	4	35,692,275	73
1988	5	26,078,975	82	1992	5	33,897,500	55	1996	5	35,891,450	65
1988	6	24,538,625	99	1992	6	35,265,700	61	1996	6	32,374,050	76
1988	7	24,962,300	105	1992	7	27,778,900	89	1996	7	16,026,050	91
1988	8	20,934,525	121	1992	8	22,494,200	105	1996	8	.	.
1988	9	14,803,475	130	1992	9	17,970,675	113	1996	9	.	.
1988	10	11,766,525	139	1992	10	8,070,650	113	1996	10	.	.

Dots indicate missing or unavailable data.
Source: Calculated from AMRIC reports

Appendix Table 8. Monthly Shipments of Florida and Imported Avocados.

		Avocado Shipments				Avocado Shipments				Avocado Shipments	
Year	Mo.	Florida (lbs.)	Imported (lbs.)	Year	Mo.	Florida (lbs.)	Imported (lbs.)	Year	Mo.	Florida (lbs.)	Imported (lbs.)
1984	11	8,916,850	.	1988	11	7,143,350	4,150,665	1992	11	159,650	15,420,000
1984	12	6,217,100	.	1988	12	5,722,100	1,384,278	1992	12	129,600	2,970,000
1985	1	4,458,050	380,046	1989	1	3,409,100	450,000	1993	1	83,050	1,180,000
1985	2	2,550,800	177,422	1989	2	978,100	0	1993	2	39,350	310,000
1985	3	443,800	37,845	1989	3	58,900	0	1993	3	7,400	140,000
1985	4	150	141,550	1989	4	0	20,000	1993	4	0	120,000
1985	5	0	127,922	1989	5	1,800	50,000	1993	5	0	210,000
1985	6	26,100	18,570	1989	6	248,800	50,000	1993	6	0	260,000
1985	7	5,901,000	63,309	1989	7	7,253,050	300,000	1993	7	154,200	860,000
1985	8	9,422,200	363,903	1989	8	11,744,150	190,000	1993	8	1,196,350	1,110,000
1985	9	9,152,900	352,606	1989	9	11,614,900	440,000	1993	9	1,698,950	1,940,000
1985	10	10,266,250	384,180	1989	10	11,250,650	2,970,000	1993	10	1,579,450	2,940,000
1985	11	8,646,700	611,071	1989	11	9,464,150	4,220,000	1993	11	1,520,750	4,700,000
1985	12	5,871,200	1,083,781	1989	12	7,831,100	1,650,000	1993	12	1,671,600	4,370,000
1986	1	4,019,800	5,252,149	1990	1	3,718,800	1,190,000	1994	1	454,600	2,070,000
1986	2	2,133,950	343,820	1990	2	1,657,800	180,000	1994	2	283,400	440,000
1986	3	66,250	19,190	1990	3	207,750	150,000	1994	3	176,300	220,000
1986	4	0	263,310	1990	4	0	0	1994	4	0	150,000
1986	5	0	70,916	1990	5	0	20,000	1994	5	1,100	180,000
1986	6	2,750	64,430	1990	6	655,200	370,000	1994	6	464,350	580,000
1986	7	2,054,300	696,959	1990	7	5,771,100	600,000	1994	7	4,170,450	1,250,000
1986	8	6,647,250	1,154,974	1990	8	7,868,050	1,980,000	1994	8	7,038,050	1,430,000
1986	9	9,229,950	1,301,051	1990	9	5,444,150	6,210,000	1994	9	7,035,400	12,990,000
1986	10	9,498,000	4,079,963	1990	10	7,778,350	9,410,000	1994	10	6,581,800	11,020,000
1986	11	6,255,100	1,996,744	1990	11	5,042,050	7,170,000	1994	11	5,654,250	17,550,000
1986	12	6,142,850	556,288	1990	12	3,523,200	2,220,000	1994	12	4,630,600	4,890,000
1987	1	4,606,250	123,778	1991	1	1,144,400	1,670,000	1995	1	2,557,150	2,960,000
1987	2	2,682,000	14,695	1991	2	340,450	970,000	1995	2	796,800	1,100,000
1987	3	692,400	1,300	1991	3	24,000	10,000	1995	3	17,600	30,000
1987	4	0	14,556	1991	4	0	70,000	1995	4	0	100,000
1987	5	4,400	64,067	1991	5	5,350	30,000	1995	5	500	560,000
1987	6	37,250	1,006,731	1991	6	1,188,650	100,000	1995	6	148,950	840,000
1987	7	4,134,500	594,953	1991	7	8,773,700	340,000	1995	7	4,356,600	780,000
1987	8	7,920,600	393,048	1991	8	10,221,850	330,000	1995	8	7,634,500	580,000
1987	9	9,672,350	336,919	1991	9	9,041,800	2,410,000	1995	9	7,173,000	1,200,000
1987	10	8,498,100	162,589	1991	10	8,738,150	14,620,000	1995	10	6,931,300	18,580,000
1987	11	8,172,300	590,952	1991	11	6,847,200	8,270,000	1995	11	5,320,450	11,630,000
1987	12	7,188,400	674,968	1991	12	6,163,900	8,770,000	1995	12	3,266,850	.
1988	1	5,738,000	294,525	1992	1	3,584,900	2,360,000	1996	1	1,654,700	.
1988	2	3,712,650	13,825	1992	2	748,050	950,000	1996	2	548,100	.
1988	3	1,400,800	0	1992	3	187,200	200,000	1996	3	151,400	.
1988	4	4,600	28,187	1992	4	0	140,000	1996	4	.	.
1988	5	0	22,712	1992	5	1,450	150,000	1996	5	.	.
1988	6	240,650	12,366	1992	6	255,400	260,000	1996	6	.	.
1988	7	6,001,600	229,791	1992	7	6,396,800	720,000	1996	7	.	.
1988	8	10,321,150	658,239	1992	8	6,724,850	740,000	1996	8	.	.
1988	9	9,879,650	2,722,730	1992	9	184,850	13,120,000	1996	9	.	.
1988	10	9,121,700	2,937,412	1992	10	200,900	16,200,000	1996	10	.	.

Source: Florida data are from various annual reports of the Florida Avocado Administrative Committee. Import data are from the U.S. Department of Commerce (via the USDA).

Appendix Table 9. Macroeconomic Data Used in the Monthly Demand Analysis, California Avocado Crop Years 1985-88.

Year	Mo.	US Disposable Personal Income (billions of dollars)	US Population (thousands)	CPI (1982-84=100) Quarterly	CPI (1982-84=100) Monthly	Price Indexes for Goods Possibly Related to Avocados: Lettuce	Tomatoes	Vegetables-1	Vegetables-2
1984	11	2,832.5	237,230	105.3	105.3	114.5	95.3	99.3	78.8
1984	12	2,832.5	237,230	105.3	105.3	90.2	90.2	96.1	73.5
1985	1	2,916.2	237,673	106.0	105.5	126.0	92.4	105.8	91.3
1985	2	2,916.2	237,673	106.0	106.0	111.0	109.7	112.9	110.3
1985	3	2,916.2	237,673	106.0	106.4	100.2	125.2	111.5	117.4
1985	4	3,002.7	238,176	107.3	106.9	86.1	159.2	111.1	109.3
1985	5	3,002.7	238,176	107.3	107.3	96.5	90.4	102.5	88.3
1985	6	3,002.7	238,176	107.3	107.6	79.4	85.0	100.9	88.5
1985	7	3,013.8	238,789	108.0	107.8	97.2	90.2	103.7	124.8
1985	8	3,013.8	238,789	108.0	108.0	109.2	85.2	98.3	103.5
1985	9	3,013.8	238,789	108.0	108.3	113.8	83.1	93.5	92.1
1985	10	3,074.9	239,387	109.0	108.7	108.1	90.8	93.9	86.8
1985	11	3,074.9	239,387	109.0	109.0	103.2	107.5	97.8	84.4
1985	12	3,074.9	239,387	109.0	109.3	143.0	124.9	110.3	107.4
1986	1	3,139.5	239,861	109.2	109.6	145.1	144.9	118.1	107.2
1986	2	3,139.5	239,861	109.2	109.3	99.2	104.3	101.4	82.7
1986	3	3,139.5	239,861	109.2	108.8	101.3	104.4	100.8	92.6
1986	4	3,170.7	240,368	109.0	108.6	128.3	108.5	108.8	116.5
1986	5	3,170.7	240,368	109.0	108.9	135.4	117.0	112.1	116.3
1986	6	3,170.7	240,368	109.0	109.5	106.8	108.3	106.4	91.0
1986	7	3,210.8	240,962	109.8	109.5	96.4	99.7	106.0	93.4
1986	8	3,210.8	240,962	109.8	109.7	98.3	94.9	105.0	90.1
1986	9	3,210.8	240,962	109.8	110.2	110.5	93.1	104.7	98.6
1986	10	3,229.1	241,539	110.4	110.3	108.2	111.8	107.2	99.5
1986	11	3,229.1	241,539	110.4	110.4	107.1	122.8	110.5	104.3
1986	12	3,229.1	241,539	110.4	110.5	115.1	126.2	111.7	100.4
1987	1	3,299.8	242,009	111.6	111.2	121.3	111.9	116.2	85.2
1987	2	3,299.8	242,009	111.6	111.6	117.7	113.4	123.2	91.9
1987	3	3,299.8	242,009	111.6	112.1	120.4	109.1	118.9	103.9
1987	4	3,298.5	242,520	113.1	112.7	121.0	119.1	123.7	102.2
1987	5	3,298.5	242,520	113.1	113.1	99.7	114.6	123.6	94.4
1987	6	3,298.5	242,520	113.1	113.5	101.3	125.6	129.2	96.4
1987	7	3,382.3	243,120	114.4	113.8	115.5	116.6	121.0	101.9
1987	8	3,382.3	243,120	114.4	114.4	139.3	97.3	114.5	77.1
1987	9	3,382.3	243,120	114.4	115.0	142.5	103.7	114.6	98.2
1987	10	3,471.8	243,721	115.4	115.3	127.7	112.5	112.5	89.6
1987	11	3,471.8	243,721	115.4	115.4	158.1	138.2	121.2	135.4
1987	12	3,471.8	243,721	115.4	115.4	272.7	139.3	140.2	112.0
1988	1	3,549.6	244,208	116.1	115.7	277.6	123.2	143.9	135.9
1988	2	3,549.6	244,208	116.1	116.0	208.0	120.1	133.7	96.8
1988	3	3,549.6	244,208	116.1	116.5	150.0	108.9	125.6	95.8
1988	4	3,600.5	244,716	117.5	117.1	113.0	129.2	127.5	98.5
1988	5	3,600.5	244,716	117.5	117.5	118.5	123.5	124.5	88.5
1988	6	3,600.5	244,716	117.5	118.0	113.5	113.3	121.8	86.6
1988	7	3,674.9	245,354	119.1	118.5	113.8	123.4	127.0	96.9
1988	8	3,674.9	245,354	119.1	119.0	118.7	123.4	125.9	94.3
1988	9	3,674.9	245,354	119.1	119.8	134.2	129.8	132.1	110.4
1988	10	3,738.4	245,966	120.3	120.2	135.1	128.7	129.4	101.0

Notes: Income and population are reported on a quarterly basis, income at a seasonally adjusted annual rate. CPI is the US Consumer Price Index for all goods and all urban consumers. The Lettuce, Tomatoes, and Vegetables-1 variables are consumer price indexes with 1982-84=100; the Vegetables-2 variable is a producer price index with 1982=100. Vegetables-1 includes potatoes, Vegetables-2 does not.

Sources: Income and Population data are from the Bureau of Economic Analysis. All price indexes are from the Bureau of Labor Statistics.

Appendix Table 9 (Continued).

Year	Mo.	US Disposable Personal Income (billions of dollars)	US Population (thousands)	CPI (1982-84=100) Quarterly	CPI (1982-84=100) Monthly	Price Indexes for Goods Possibly Related to Avocados: Lettuce	Tomatoes	Vegetables-1	Vegetables-2
1988	11	3,738.4	245,966	120.3	120.3	126.8	129.2	126.7	103.8
1988	12	3,738.4	245,966	120.3	120.5	174.3	124.3	133.0	96.7
1989	1	3,828.3	246,460	121.7	121.1	179.7	121.7	141.4	93.4
1989	2	3,828.3	246,460	121.7	121.6	167.2	153.3	144.4	119.9
1989	3	3,828.3	246,460	121.7	122.3	150.7	132.1	140.2	111.0
1989	4	3,867.1	247,017	123.7	123.1	134.2	145.6	144.1	107.1
1989	5	3,867.1	247,017	123.7	123.8	128.1	189.0	153.2	140.4
1989	6	3,867.1	247,017	123.7	124.1	149.1	131.6	150.8	117.0
1989	7	3,912.1	247,698	124.7	124.4	145.5	124.9	150.8	110.5
1989	8	3,912.1	247,698	124.7	124.6	146.5	119.3	145.1	96.3
1989	9	3,912.1	247,698	124.7	125.0	152.6	115.7	133.9	81.5
1989	10	3,970.3	248,374	125.9	125.6	160.4	126.2	134.8	101.0
1989	11	3,970.3	248,374	125.9	125.9	167.9	134.9	141.9	80.0
1989	12	3,970.3	248,374	125.9	126.1	135.8	140.3	136.5	88.4
1990	1	4,074.7	248,928	128.0	127.4	152.9	246.3	176.9	164.0
1990	2	4,074.7	248,928	128.0	128.0	134.2	321.8	186.3	203.2
1990	3	4,074.7	248,928	128.0	128.7	130.2	248.4	168.3	136.6
1990	4	4,143.3	249,564	129.3	128.9	137.1	117.6	145.6	74.8
1990	5	4,143.3	249,564	129.3	129.2	134.3	108.5	139.8	78.0
1990	6	4,143.3	249,564	129.3	129.9	120.2	126.1	140.0	83.7
1990	7	4,207.5	250,299	131.6	130.4	140.8	122.7	143.8	93.3
1990	8	4,207.5	250,299	131.6	131.6	142.4	122.0	139.8	79.0
1990	9	4,207.5	250,299	131.6	132.7	172.3	121.9	137.3	79.4
1990	10	4,241.4	251,031	133.7	133.5	192.8	133.2	142.2	96.2
1990	11	4,241.4	251,031	133.7	133.8	194.7	131.8	149.5	117.7
1990	12	4,241.4	251,031	133.7	133.8	152.0	129.5	144.0	87.2
1991	1	4,263.2	251,650	134.8	134.6	189.3	141.1	159.9	89.3
1991	2	4,263.2	251,650	134.8	134.8	160.9	131.6	152.5	87.3
1991	3	4,263.2	251,650	134.8	135.0	139.9	146.0	151.1	88.4
1991	4	4,329.6	252,295	135.6	135.2	154.0	181.3	169.2	112.8
1991	5	4,329.6	252,295	135.6	135.6	168.4	209.3	167.3	157.0
1991	6	4,329.6	252,295	135.6	136.0	180.8	243.2	180.5	138.0
1991	7	4,365.6	253,033	136.7	136.2	138.8	179.4	157.7	102.0
1991	8	4,365.6	253,033	136.7	136.6	133.8	120.4	142.2	82.6
1991	9	4,365.6	253,033	136.7	137.2	140.1	119.0	137.6	81.8
1991	10	4,416.4	253,743	137.7	137.4	139.7	113.5	134.0	73.5
1991	11	4,416.4	253,743	137.7	137.8	201.8	127.9	149.6	113.1
1991	12	4,416.4	253,743	137.7	137.9	170.1	124.5	150.7	76.1
1992	1	4,515.3	254,338	138.7	138.1	149.6	148.8	152.7	117.2
1992	2	4,515.3	254,338	138.7	138.6	132.6	213.0	163.5	154.7
1992	3	4,515.3	254,338	138.7	139.3	141.1	261.6	172.7	147.9
1992	4	4,585.2	255,032	139.8	139.5	148.0	251.1	175.4	99.7
1992	5	4,585.2	255,032	139.8	139.7	149.6	133.0	149.6	89.9
1992	6	4,585.2	255,032	139.8	140.2	136.9	120.9	146.9	81.3
1992	7	4,613.9	255,815	140.9	140.5	135.3	126.6	148.1	85.5
1992	8	4,613.9	255,815	140.9	140.9	167.0	130.1	153.8	114.8
1992	9	4,613.9	255,815	140.9	141.3	192.5	125.5	152.8	114.8
1992	10	4,740.4	256,543	141.9	141.8	176.8	161.0	155.2	149.0

Notes: Income and population are reported on a quarterly basis, income at a seasonally adjusted annual rate. CPI is the US Consumer Price Index for all goods and all urban consumers. The Lettuce, Tomatoes, and Vegetables-1 variables are consumer price indexes with 1982-84=100; the Vegetables-2 variable is a producer price index with 1982=100. Vegetables-1 includes potatoes, Vegetables-2 does not.

Sources: Income and Population data are from the Bureau of Economic Analysis. All price indexes are from the Bureau of Labor Statistics.

Appendix Table 9 (Continued).

Year	Mo.	US Disposable Personal Income (billions of dollars)	US Population (thousands)	CPI (1982-84=100) Quarterly	CPI (1982-84=100) Monthly	Price Indexes for Goods Possibly Related to Avocados: Lettuce	Tomatoes	Vegetables-1	Vegetables-2
1992	11	4,740.4	256,543	141.9	142.0	156.2	196.1	158.4	108.2
1992	12	4,740.4	256,543	141.9	141.9	183.0	193.4	166.1	133.4
1993	1	4,686.1	257,155	143.1	142.6	181.6	182.7	172.4	128.8
1993	2	4,686.1	257,155	143.1	143.1	187.3	170.9	171.1	125.8
1993	3	4,686.1	257,155	143.1	143.6	222.5	139.6	173.7	117.4
1993	4	4,771.6	257,787	144.2	144.0	213.1	159.2	179.3	178.5
1993	5	4,771.6	257,787	144.2	144.2	195.5	235.9	189.6	164.3
1993	6	4,771.6	257,787	144.2	144.4	142.2	193.2	167.1	80.7
1993	7	4,804.2	258,501	144.8	144.4	164.5	131.1	155.8	98.4
1993	8	4,804.2	258,501	144.8	144.8	173.8	134.2	156.1	110.5
1993	9	4,804.2	258,501	144.8	145.1	172.2	164.8	157.4	117.0
1993	10	4,895.4	259,192	145.8	145.7	168.1	147.7	157.7	89.5
1993	11	4,895.4	259,192	145.8	145.8	165.3	159.6	166.1	141.1
1993	12	4,895.4	259,192	145.8	145.8	152.1	197.2	174.9	167.0
1994	1	4,856.8	259,738	146.7	146.2	146.3	238.5	181.7	146.3
1994	2	4,856.8	259,738	146.7	146.7	146.5	175.1	168.1	99.3
1994	3	4,856.8	259,738	146.7	147.2	158.8	148.5	167.0	96.1
1994	4	5,002.2	260,327	147.6	147.4	144.9	150.7	163.9	91.4
1994	5	5,002.2	260,327	147.6	147.5	143.3	152.7	162.8	91.2
1994	6	5,002.2	260,327	147.6	148.0	147.6	170.0	168.7	94.9
1994	7	5,070.5	261,004	148.9	148.4	156.2	162.1	170.2	104.8
1994	8	5,070.5	261,004	148.9	149.0	157.3	159.2	163.7	95.7
1994	9	5,070.5	261,004	148.9	149.4	178.7	154.6	163.5	107.1
1994	10	5,145.7	261,653	149.6	149.5	178.8	158.1	167.0	113.8
1994	11	5,145.7	261,653	149.6	149.7	212.3	178.5	178.4	128.1
1994	12	5,145.7	261,653	149.6	149.7	273.4	233.6	212.7	244.7
1995	1	5,225.5	262,181	150.9	150.3	257.2	217.1	209.4	163.5
1995	2	5,225.5	262,181	150.9	150.9	176.1	217.2	198.6	149.2
1995	3	5,225.5	262,181	150.9	151.4	178.1	175.0	193.8	159.2
1995	4	5,260.5	262,748	152.2	151.9	379.6	202.3	220.4	199.1
1995	5	5,260.5	262,748	152.2	152.2	342.2	159.0	203.5	167.2
1995	6	5,260.5	262,748	152.2	152.5	209.5	178.2	194.9	127.2
1995	7	5,337.3	263,399	152.9	152.5	167.9	200.7	188.7	107.3
1995	8	5,337.3	263,399	152.9	152.9	177.5	150.9	175.4	94.8
1995	9	5,337.3	263,399	152.9	153.2	222.0	157.2	181.7	152.9
1995	10	5,406.6	264,032	153.6	153.7	193.1	175.7	182.0	116.0
1995	11	5,406.6	264,032	153.6	153.6	178.5	183.5	180.3	115.8
1995	12	5,406.6	264,032	153.6	153.5	172.2	242.6	188.4	125.5
1996	1	5,479.0	264,557	155.0	154.4	201.6	178.1	193.8	133.9
1996	2	5,479.0	264,557	155.0	154.9	165.6	178.0	188.4	119.4
1996	3	5,479.0	264,557	155.0	155.7	208.8	237.4	206.0	202.5
1996	4	.	.	156.5	156.3	189.3	292.3	209.2	155.6
1996	5	.	.	156.5	156.6	176.3	227.5	190.0	108.2
1996	6	.	.	156.5	156.7	183.4	190.3	188.0	96.6
1996	7	.	.	.	.	.	.	.	.
1996	8	.	.	.	.	.	.	.	.
1996	9	.	.	.	.	.	.	.	.
1996	10	.	.	.	.	.	.	.	.

Notes: Income and population are reported on a quarterly basis, income at a seasonally adjusted annual rate. CPI is the US Consumer Price Index for all goods and all urban consumers. The Lettuce, Tomatoes, and Vegetables-1 variables are consumer price indexes with 1982-84=100; the Vegetables-2 variable is a producer price index with 1982=100. Vegetables-1 includes potatoes, Vegetables-2 does not.

Sources: Income and Population data are from the Bureau of Economic Analysis. All price indexes are from the Bureau of Labor Statistics.

Appendix Table 10. Bearing Acreage of California Avocados: Actual and Simulated With and Without Advertising, 1961-62 through 1994-95.

Year	Actual	Estimated Bearing Acreage	
	Bearing Acreage	With Advertising	Without Advertising
1962	21,194	21,194	21,194
1963	21,921	21,082	21,082
1964	21,574	20,702	20,698
1965	18,810	20,065	20,048
1966	18,620	19,228	19,196
1967	18,730	18,748	18,701
1968	19,220	18,145	18,063
1969	18,040	17,588	17,448
1970	18,380	17,731	17,486
1971	19,039	17,650	17,280
1972	19,611	18,425	17,852
1973	20,741	19,763	18,934
1974	20,715	22,194	21,037
1975	24,882	25,225	23,725
1976	29,041	30,384	28,530
1977	33,866	35,567	33,355
1978	39,802	41,458	38,801
1979	44,369	47,097	44,027
1980	47,831	53,091	49,609
1981	64,798	68,827	65,056
1982	69,448	72,950	68,929
1983	72,296	74,509	70,295
1984	72,861	75,779	71,446
1985	74,131	76,289	71,819
1986	74,812	76,158	71,635
1987	76,307	75,536	71,012
1988	75,062	74,918	70,389
1989	73,368	72,969	68,471
1990	71,007	71,508	67,140
1991	69,582	68,466	64,094
1992	68,159	67,172	62,634
1993	66,865	64,962	60,357
1994	61,254	62,526	57,914
1995	59,577	59,764	55,196

Appendix Table 11a. Estimated Annual Short-Run Benefit/Cost Ratios From Avocado Advertising, 1961-62 to 1994-95.

Year	Short-Run Impacts of Advertising						
	Estimated TR with Advertising (million $)	Estimated TR with no Advertising (million $)	TR Increase From Advertising (million $)	CAC Advertising (million $)	TR increase 1994-95 dollars (million $)	CAC Adv 1994-95 dollars (million $)	Benefit/ Cost Ratio
1962	10.89	10.75	0.15	0.18	0.74	0.91	0.81
1963	10.63	10.27	0.36	0.44	1.77	2.18	0.81
1964	12.28	11.81	0.47	0.51	2.32	2.49	0.93
1965	9.09	8.84	0.24	0.32	1.18	1.55	0.76
1966	17.88	16.84	1.04	0.79	4.89	3.70	1.32
1967	20.86	19.70	1.16	0.78	5.30	3.56	1.49
1968	18.34	17.47	0.87	0.58	3.81	2.52	1.51
1969	22.65	21.28	1.36	0.79	5.65	3.29	1.72
1970	21.61	20.19	1.43	0.76	5.60	2.99	1.88
1971	30.94	28.07	2.87	1.21	10.80	4.56	2.37
1972	24.35	21.81	2.54	1.10	9.28	4.02	2.31
1973	45.91	40.65	5.26	1.29	18.06	4.42	4.09
1974	51.53	44.66	6.87	1.55	21.24	4.78	4.44
1975	63.14	53.70	9.44	2.15	26.74	6.10	4.39
1976	75.29	63.22	12.07	2.15	32.33	5.76	5.61
1977	90.52	71.60	18.92	4.14	47.58	10.40	4.58
1978	117.95	94.93	23.02	3.60	53.80	8.41	6.40
1979	125.97	100.94	25.03	4.12	52.54	8.66	6.07
1980	136.59	114.32	22.28	2.72	41.21	5.02	8.21
1981	109.89	89.01	20.88	6.42	35.01	10.77	3.25
1982	130.17	111.06	19.12	3.19	30.19	5.04	5.99
1983	113.74	92.65	21.09	5.42	32.27	8.29	3.89
1984	105.33	89.24	16.10	3.47	23.61	5.09	4.64
1985	146.00	120.57	25.43	4.06	36.01	5.75	6.26
1986	197.36	156.56	40.80	5.18	56.73	7.21	7.87
1987	133.75	103.94	29.80	7.58	39.98	10.17	3.93
1988	232.39	190.42	41.97	3.36	54.06	4.33	12.48
1989	292.56	220.77	71.79	7.11	88.23	8.74	10.10
1990	311.27	235.68	75.59	6.33	88.14	7.38	11.95
1991	285.71	213.37	72.34	7.35	80.94	8.23	9.84
1992	224.14	164.63	59.51	8.63	64.64	9.37	6.90
1993	170.51	130.37	40.14	6.82	42.33	7.19	5.89
1994	299.58	226.27	73.31	5.10	75.39	5.25	14.37
1995	290.45	211.69	78.76	6.82	78.76	6.82	11.56

Appendix Table 11b. Estimated Long-Run Benefit/Cost Ratios From Avocado Advertising, 1961-62 to 1994-95.

Year	Long-run Impacts of Advertising						
	Estimated TR with Advertising (million $)	Estimated TR with no Advertising (million $)	TR Increase From Advertising (million $)	CAC Advertising (million $)	TR increase 1994-95 dollars (million $)	CAC Adv 1994-95 dollars (million $)	Benefit/ Cost Ratio
1962	10.78	10.64	0.15	0.18	0.73	0.91	0.80
1963	10.66	10.30	0.36	0.44	1.78	2.18	0.81
1964	12.72	12.22	0.49	0.51	2.41	2.49	0.97
1965	9.30	9.06	0.25	0.32	1.21	1.55	0.78
1966	17.60	16.60	1.00	0.79	4.70	3.70	1.27
1967	20.75	19.65	1.11	0.78	5.06	3.56	1.42
1968	18.66	17.81	0.85	0.58	3.71	2.52	1.47
1969	24.26	22.92	1.34	0.79	5.57	3.29	1.69
1970	21.84	20.53	1.31	0.76	5.15	2.99	1.72
1971	32.27	29.78	2.49	1.21	9.38	4.56	2.05
1972	24.88	22.55	2.33	1.10	8.49	4.02	2.11
1973	46.04	42.48	3.56	1.29	12.23	4.42	2.77
1974	47.28	42.94	4.35	1.55	13.43	4.78	2.81
1975	50.09	46.78	3.30	2.15	9.36	6.10	1.54
1976	61.56	55.43	6.13	2.15	16.42	5.76	2.85
1977	55.46	49.99	5.47	4.14	13.75	10.40	1.32
1978	70.69	64.87	5.81	3.60	13.59	8.41	1.62
1979	76.75	70.95	5.81	4.12	12.19	8.66	1.41
1980	99.95	92.79	7.16	2.72	13.24	5.02	2.64
1981	40.40	39.43	0.97	6.42	1.62	10.77	0.15
1982	88.32	86.15	2.16	3.19	3.42	5.04	0.68
1983	89.31	84.63	4.68	5.42	7.16	8.29	0.86
1984	86.10	86.46	-0.36	3.47	-0.53	5.09	-0.10
1985	118.31	115.41	2.91	4.06	4.12	5.75	0.72
1986	162.99	151.65	11.34	5.18	15.77	7.21	2.19
1987	109.10	103.89	5.21	7.58	6.99	10.17	0.69
1988	196.59	192.77	3.82	3.36	4.92	4.33	1.13
1989	247.17	223.14	24.02	7.11	29.53	8.74	3.38
1990	254.74	224.60	30.13	6.33	35.14	7.38	4.76
1991	235.73	210.06	25.67	7.35	28.73	8.23	3.49
1992	183.81	163.68	20.13	8.63	21.87	9.37	2.33
1993	146.31	144.76	1.55	6.82	1.63	7.19	0.23
1994	251.50	235.14	16.35	5.10	16.82	5.25	3.20
1995	228.36	211.42	16.95	6.82	16.95	6.82	2.49

Appendix Table 11c. Estimated Long-Run Benefit/Cost Ratios From Avocado Advertising For The Producers' Share of Costs, 1961-62 to 1994-95.

Long-run Impacts of Advertising				
Crop Year Ending	TR Increase From Adv 1994-95 base (million $)	CAC Adv Costs 1994-95 base (million $)	Producers' Share of Costs 1994-95 base (million $)	Benefit/ Cost Ratio
1962	0.7329	0.9129	0.9129	0.80
1963	1.7769	2.1848	2.1848	0.81
1964	2.4141	2.4892	2.4892	0.97
1965	1.2081	1.5525	1.5525	0.78
1966	4.6989	3.6952	3.6952	1.27
1967	5.0589	3.5637	3.5637	1.42
1968	3.7120	2.5199	2.5502	1.46
1969	5.5716	3.2876	3.3753	1.65
1970	5.1487	2.9861	3.3622	1.53
1971	9.3763	4.5649	4.8225	1.94
1972	8.4901	4.0169	5.2581	1.61
1973	12.2311	4.4189	4.5892	2.67
1974	13.4347	4.7809	5.6285	2.39
1975	9.3594	6.0961	3.7529	2.49
1976	16.4241	5.7620	5.8632	2.80
1977	13.7537	10.3991	6.7154	2.05
1978	13.5874	8.4052	4.5256	3.00
1979	12.1912	8.6551	4.4918	2.71
1980	13.2441	5.0219	3.8131	3.47
1981	1.6197	10.7710	8.2321	0.20
1982	3.4167	5.0414	2.4797	1.38
1983	7.1584	8.2908	5.3306	1.34
1984	-0.5275	5.0941	1.9655	-0.27
1985	4.1161	5.7528	2.4705	1.67
1986	15.7686	7.2072	3.9103	4.03
1987	6.9890	10.1685	6.3259	1.10
1988	4.9164	4.3332	0.2258	21.77
1989	29.5267	8.7354	4.1010	7.20
1990	35.1371	7.3753	5.9987	5.86
1991	28.7269	8.2259	5.9336	4.84
1992	21.8671	9.3726	7.5513	2.90
1993	1.6310	7.1887	3.8668	0.42
1994	16.8167	5.2479	3.5628	4.72
1995	16.9453	6.8152	4.6479	3.65

Appendix Table 11d. Projected Long-Run Benefit/Cost Ratios From Avocado Advertising, Producers Pay All Costs and Producers Share Costs, 1995-96 to 2014-15.

Projected Long-run Impacts of Advertising								
Crop	Total Crop Revenue		Increased	Total	Producers'	Benefit/Cost Ratios	
Year Ending	With Adv	Without Adv	Rev from Adv	Adv Cost	Share of Adv Costs	Producers pay all costs	Producers share costs
	(million $)	(million $)	(million $)	(million $)	(million $)		
1996	217.01	206.92	10.09	4.47	1.72	2.26	5.86
1997	221.67	212.09	9.58	4.47	1.86	2.14	5.16
1998	228.72	219.51	9.21	4.47	1.83	2.06	5.02
1999	237.86	228.55	9.32	4.47	1.74	2.08	5.35
2000	247.32	237.61	9.71	4.47	1.67	2.17	5.83
2001	256.86	246.56	10.30	4.47	1.60	2.30	6.45
2002	265.93	254.79	11.13	4.47	1.65	2.49	6.75
2003	273.76	261.94	11.82	4.47	1.77	2.64	6.66
2004	282.61	269.85	12.76	4.47	1.91	2.85	6.69
2005	292.37	278.40	13.97	4.47	2.07	3.12	6.74
2006	302.42	287.15	15.28	4.47	2.24	3.42	6.82
2007	312.53	295.93	16.60	4.47	2.41	3.71	6.88
2008	322.63	304.74	17.89	4.47	2.59	4.00	6.90
2009	332.85	313.76	19.09	4.47	2.76	4.27	6.91
2010	343.30	323.13	20.17	4.47	2.91	4.51	6.92
2011	354.04	332.94	21.11	4.47	3.03	4.72	6.96
2012	365.11	343.24	21.87	4.47	3.11	4.89	7.04
2013	376.45	354.01	22.44	4.47	3.14	5.02	7.14
2014	388.08	365.28	22.81	4.47	3.13	5.10	7.28
2015	400.05	377.08	22.97	4.47	3.08	5.14	7.45