The California Prune Board's Promotion Program: An Evaluation

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EXECUTIVE SUMMARY

California is the world leader in prune production, accounting for about 99 percent of U.S. production and 70 percent of the world's supply. The industry, through the California Prune Board (CPB) and its various packers, especially Sunsweet Growers, the largest marketer of California prunes, has invested substantially in the promotion of prunes to consumers. This study analyzes the effectiveness of these expenditures in increasing consumer demand for prunes and, thereby, in raising industry revenues. The results from this project are useful for decision makers in the California prune industry as well as to researchers studying the effects of promotion on market demand. The analysis used to derive the results is also pertinent to other California commodity groups, in light of increased scrutiny surrounding generic promotion programs. The study was conducted under an agreement between the CPB and the University of California, and was carried out by a research team of faculty and graduate students in the Department of Agricultural and Resource Economics at the University of California, Davis.

The study involved econometric analyses of U.S. domestic demand for California prunes. Economic theory implies that, to be effective, expenditures on promotion must increase consumers' demand for the product being promoted. Other factors generally considered to influence demand, and which need to be incorporated into a demand study, include the price of prunes, the prices of close substitutes or complements, measures of consumers' purchasing power, and factors to account for any time trends or seasonality in demand.

Three data sets were assembled to study prune demand. The main data set consisted of 51 observations on retail prune consumption and prices in the United States, reported in monthly intervals for the period September 1992 to July 1996. Expenditures on promotion by the California Prune Board and by Sunsweet Growers were closely matched to the four-week observations on sales for this period. A second data set consisted of annual observations on domestic prune shipments and prices for the period 1949 to 1995. The measure of promotion in the annual model consisted of annual real expenditures by the CPB and Sunsweet on all types of domestic promotion. A third data set consisted of the results of a test market analysis of television advertising for prunes conducted in six U.S. cities.

Results from analysis of the monthly data indicate that prune promotion has increased the demand for prunes. Across several alternative model specifications examined and reported in part 3, prune promotion consistently had a statistically significant, positive impact on retail prune sales. For the various models estimated using ordinary least squares (OLS), the elasticity of sales with respect to promotion generally ranged from 0.17 to 0.22, while the promotion elasticity in the model estimated using 2SLS was 0.21. This means that a 10 percent increase in

expenditures on promotion would have increased sales about 2 percent, holding price and other explanatory variables constant.

The models based on the annual data series did not perform as well. Promotion, measured in this case by annual real expenditures by the CPB and Sunsweet on all types of domestic promotion, generally did not have a statistically significant effect on demand. Such results were not believable, however, in light of diagnostic tests that we performed to evaluate our specification of the structure of these annual demand models. The tests led us to conclude that—either because of poor or missing data or an incorrect model form—the models were not specified correctly. Thus, we were unable to use the annual data in any meaningful way.

The television advertising test-market campaign was conducted for 12 weeks in Fall 1990, with three cities selected as test markets, and three used as controls. The advertisements featured generic advertising of dried prunes. Our analysis of the test-market data indicates that the television advertisements had a positive and statistically significant effect on prune demand both during the period of the advertising campaign and during the post-test period. The model we developed indicated that in-store displays, by themselves, had no impact on prune sales.

A simulation approach was used to translate the effects of promotion on prune demand into estimates of the resulting marginal benefits (the increase in industry revenues from an incremental increase in promotional expenditures) to prune growers. Because of our greater faith in the data underpinning the monthly analysis of demand, the superior statistical performance of models estimated using the monthly data, and the congruence of these model results with the results from the test-market analysis, we based our simulation analysis on results from models estimated from the monthly data. Because the statistical analysis was restricted to demand modeling, while the simulation analysis required a complete model of the industry, including supply response, it was necessary to construct a synthetic supply model and conduct simulations for a variety of alternative supply specifications.

The marginal benefit-cost ratio for promotion of California prunes was calculated. This ratio refers to the net revenues generated from incremental expenditure on promotion, and hinges importantly on the value of the price elasticity of supply, and on whether growers bear the entire burden of funding the expenditures or some of the burden is shifted to consumers in the form of higher prices. Returns to growers from allocating expenditures to promotion would be maximized by expanding expenditures until the marginal (last) dollar spent on promotion yields just a dollar back in revenues. The analysis suggests that the industry stopped short of this optimizing condition during the 1992-1996 period covered by the monthly data. The calculated marginal benefit of an additional dollar spent on promotion, given the amounts actually expended, ranged from $2.65 to almost $30.00, suggesting that additional promotion expenditures would have generated positive net revenues to producers. Only when producers are (implausibly) assumed to bear the entire cost of the promotion is it possible to derive average benefit-cost ratios less than 1:1, and to do so requires an elasticity of supply of 1.0 or more, which is only likely to be relevant for longer-run changes.

We conclude that promotion of California prunes conducted by the CPB has increased the demand for prunes and returns to producers of prunes. Over the four-year period analyzed in the monthly model, investments by prune growers in promotion yielded them marginal returns of at least $2.65 for every dollar spent. Moreover, marginal benefit-cost ratios in the range of 2.7:1 and higher indicate that the industry could have profitably invested even more in promotion during this period.

1. INTRODUCTION

The objective of this study is to evaluate the economic impacts of industry-financed market development and promotion activities for California prunes. Using a state marketing order program first established in 1952, all California prune producers pay mandatory assessments that are administered by the California Prune Board (CPB) to promote and increase the demand for California prunes. The central questions addressed by this study are: (a) how have CPB marketing expenditures affected the demand for and sales of California prunes, and (b) have net revenues to producers from CPB marketing programs increased enough to offset program costs? Answering these questions requires the development of an econometric model of the demand for prunes, using time-series data on economic variables that have important effects on the consumption of prunes.

The report is organized in line with the steps taken to answer the research questions. The first step is to document developments with economic implications for the California prune industry, and construct a data base for the analysis. This is done in the next section of the report (part 2), with documentation and discussion of the California prune industry in the post-World War II era. Supply factors, including changing patterns of production, planted area, yields, and varieties are discussed first, followed by demand factors, including changing domestic and international markets, prices, and patterns of consumption. Part 3 reports the results of modeling the monthly and annual per capita demands for prunes. The models are specified, the variables are defined and described, the models are estimated, diagnostic tests are performed, and the results are interpreted.

The monthly econometric estimates are used as the basis for a benefit-cost evaluation of the Prune Board's marketing programs in part 4. Three approaches are used to estimate marginal benefit-cost ratios for grower expenditures on prune promotion. First, the elasticities estimated in the monthly demand models are used to approximate the ratios. Second, the estimated models are used to calculate marginal returns from promotion, using a range of supply elasticities. Third, Monte-Carlo simulations are performed, to obtain confidence intervals on the benefit-cost ratios for each of the estimated monthly models. An annual model is also estimated, but is not used in the benefit-cost analysis. Part 5 presents and discusses the results of some test-market studies of the demand for prunes. Finally, part 6 summarizes the main findings, interprets the results, and presents conclusions.

2. THE CALIFORNIA PRUNE INDUSTRY — 1949 TO PRESENT

Economic and crop statistics on developments and changes in the California prune industry, especially since 1949, provide the institutional background and data required to develop the econometric models of prune demand.

2.1 Prune Production in California

The California prune is a descendent of La Petite d'Agen, a prune plum native to Southwest France. Prune trees were introduced to the United States in 1856, when Pierre Pellier brought prune cuttings from France to the Santa Clara Valley in California. Prunes thrived under California climatic conditions, and the industry was well-established and growing by the early 1900s. The earliest California Department of Agriculture acreage statistics for prunes recorded total 1919 acreage of 154,279 acres—106,880 bearing and 47,399 non-bearing. Even though current acreage is substantially less, California now accounts for about 99 percent of annual U.S. prune production, and an average of about 70 percent of the world's annual supply of prunes (CPB 1996).

Trends in Acreage

California prune acreage has varied significantly through time, but has remained rather stable over the past decade (1985-1994). Initially concentrated in the Santa Clara, Sonoma, and Napa Valleys, bearing acreage of California prunes peaked at 174,050 acres in 1930, then declined steadily to 101,377 acres in 1950, reached a temporary low of 80,122 acres in 1960, expanded to 97,560 acres in 1969, decreased again to the lowest recorded acreage of 65,400 acres in 1981, and then expanded from 1982 to 1990 (figure 2.1). Since 1990, bearing acreage has varied from 77,588 to 80,100 acres, but it appears that acreage is increasing as a result of recent new plantings. Sales of prune trees by California nurseries increased from 300,000 in 1989 to over 1.5 million in 1994, and continued at high rates in 1995 and 1996 (table 2.1). At the same time, non-bearing acreage of California prunes increased from an estimated 6,000 acres in 1990 to 17,000 acres in 1993 (CPB, January 1996).

The location of planted acreage has also changed over time. Most California prune orchards were located in the Coastal Valleys before 1950, but population pressures and more profitable alternative crops led to the removal of the majority of that acreage. At the same time, when prune trees were being removed in the Coastal Valleys, new prune orchards were being planted in the Central Valley (Dale et al. 1988). Now, prune acreage (and production) is concentrated in the Sacramento Valley. Counties with more than 3,000 acres of prune trees in 1992 included

Table 2.1: *Prune Tree Sales in California*

Year	Number of Prune Trees (1,000)
1989	300
1990	450
1991	550
1992	610
1993	900
1994	1,504
1995	985
1996	650

Source: California Prune News: Annual Report, January 1996.
Notes: 1996 value is a projection.

Butte (10,439), Colusa (3,825), Glenn (7,561), Sutter (21,364), Tehama (9,138), Tulare (5,571), and Yuba (10,857). The 1992 acreage in counties where prune production was concentrated in 1950 includes Napa (93), Santa Clara (1,937), and Sonoma (1,252).

Trends in Yields and Production

Data on average per acre yields of prunes during the period since 1949 show an upward trend, with significant year-to-year variation (figure 2.2). The annual yield variability is primarily the result of weather conditions and the alternate-bearing tendencies of tree crops. Average yields of 2.21 tons per acre for the 5-year period 1991-1995 were 38 percent higher than the average of 1.60 tons per acre for the 5-year period 1950-1954. Possible reasons for the increase in average yields include cultural methods (improvements in pruning and tree spacing) and the changing location of production (yields are higher in the Central Valley than in the Coastal Valleys) (Dale et al. 1988). Variety improvements have resulted in improved yields for other tree crops, but do not appear to have been an important factor for prunes. The California prune industry has relied almost exclusively on the French and Improved French varieties, which have recently accounted for about 97 percent of bearing acreage and continue to account for the majority of non-bearing acreage (1995 California Prune Acreage Survey). These varieties have the desirable feature for mechanical harvesting that the fruit remains on the tree when ripe. Other commercial prune varieties, which account for the remaining two to three percent of acreage, include Friedman, Imperial, Robes de Sergeant, Moyer, Victor LG, and 707. The CPB is funding research to support development of new prune varieties that are earlier-maturing than Improved French, yet retain its desirable product qualities. If successful, such a variety will provide significant economic advantages from improved utilization of harvest labor, equipment, and processing capacity.

Significant year-to-year variation in total production of California prunes results from the variability of average yields (figures 2.1 and 2.2). The increased average yields per acre during the 1950-1995 period more than offset the observed reduction in bearing acreage. Total production increased from an annual average of 157,200 tons during the 1950-1954 period to an annual average of 172,600 tons during the 1991-1995 period. A simple linear trend regression equation estimated for yields over the period 1949 through 1995 resulted in a trend coefficient of 0.017 (t-value = 4.29), indicating that average California prune yields increased by 0.017 tons (34 pounds) per acre per year.

Trends in Prices and Value of Production

Average annual prices received by California prune growers are shown in figure 2.3. These prices, in dollars per ton of prunes in natural condition, are presented in both nominal and real terms. The real prices, in 1995 dollars, were obtained by deflating nominal prices by the Consumer Price Index (1995 = 1.00).

Variations in annual crop size have contributed to fluctuations in the price per ton for prunes, with the expected inverse relationship between average price and annual quantity. For example, small prune crops in 1958 and 1972 were associated with high prices. Real prune prices generally declined until 1989, but have increased slightly since then. The total value of California prune production, in real terms, generally declined until 1986, and has increased since 1987 (figure 2.4).

2.2 Marketing California Prunes

The marketing process for prunes has changed over time, but the changes have been gradual rather than dramatic. This section describes some prune industry changes, outlines trends in prune consumption, and discusses trends in some possible determinants of prune demand.

Harvest and Processing

California prunes are typically machine-harvested from mid-August to mid-September, with the harvest date for a given orchard determined by a combination of fruit firmness and sugar content. While prunes were once harvested by hand in three or four "pickings" of an orchard, today most California prunes are harvested by machine, with a single pass through the orchard. Immediately after harvesting, the ripe prunes are washed, placed on large wooden trays, and dehydrated to about 21 percent moisture content. The typical conversion rate in processing is three pounds of fresh fruit to one pound of dried prunes. After dehydration, prunes are graded for size, inspected, and put into storage in bulk containers; these dehydrated prunes are stored in what is known as "natural condition." When the processor receives orders, the fruit is removed from storage and partially rehydrated to 24-30 percent moisture to make the prunes softer and more pliable. The partially rehydrated prunes are then sterilized, inspected, packaged, and shipped. The only preservative used in processing prunes is potassium sorbate (the potassium salt of sorbic acid), which is used to protect against mold and yeast spoilage (CPB 1996).

Trends in Consumption, Imports, and Exports

Domestic shipments and exports of California prunes during the 1949-1994 period are shown in figure 2.5. Since 1949, domestic shipments of California prunes have generally declined, while exports of California prunes have tended to increase, in both absolute and percentage terms. Currently, about 60 percent of California's annual prune shipments are consumed in the United States and about 40 percent are exported, as compared with average shares of 83 percent domestic and 17 percent export during the years from 1949 through 1953. Domestic prune shipments dipped to 85,000 tons in 1978, and remained below 100,000 tons annually until 1987, when they reached 103,000 tons. After peaking at 117,700 tons in 1989, domestic prune shipments decreased to a little over 94,000 tons in 1995. California prune exports reached 71,000 tons in 1989 and peaked at almost 79,500 tons in 1990. Exports have remained over 70,000 tons annually since 1989, except during 1993, when exports dipped to just under 61,000 tons. Germany and Japan have recently been the leading importers of U.S. prunes, followed by Italy, the United Kingdom, and Canada. U.S. imports of prune products increased in the early 1990s, but still remain very small relative to California production. During 1984-92, U.S. imports as a percentage of U.S. exports of dried prunes ranged from 0.7 percent in 1987 to 2.4 percent in 1992 (USDA *Agricultural Statistics*).

Prune Shipments by Product Category

The four major product categories for prunes, with their 1995 shares of total domestic shipments, are: dried pitted (50%), dried with pits (10%), juice and concentrate (38%), and canned prunes (2%). While the proportion of the annual crop in each category has changed over time, the most dramatic change has been from dried prunes with pits to dried pitted prunes. The pitted prunes share of total dried prunes remained under two percent until 1961, increased to 12 percent by 1965, and then increased rather steadily through time to 85 percent in 1994 and 83 percent in 1995. This increase in the market share of pitted prunes is the result of improvements in pitting technology, which permit removal of the prune pit with minimal skin break and very little change in the shape of the prune. Given the improved quality of pitted prunes, consumers in the United States and worldwide have been switching from prunes with pits to pitted prunes. Domestic shipments of California prunes by product category are shown in figure 2.6. Since 1986, the California prune industry has shipped more pitted prunes than prunes with pits.

Domestic shipments of prune juice and concentrate have declined since the early 1960s. Prune juice is prepared from a water extract of dried prunes and contains not less than 18.5 percent by weight of water-soluble solids extracted from dried prunes. Prune juice may contain one or more optional acidifying ingredients: lemon or lime juice or citric acid. Prune juice may also contain honey, in a quantity not less than two percent nor more than three percent by weight, and may contain Vitamin C, not less than 30 milligrams nor more than 50 milligrams per 6 oz. serving (CPB 1996). Prune juice concentrate is a viscous form of prune juice, packed at 70° Brix (soluble solids) minimum, with higher Brix packs for export shipments or on special orders. No preservatives are added to prune juice concentrate, as the 70° Brix concentrate is self-preserving (CPB 1996). These standards contribute to a uniform product.

In the United States, relatively few prunes are eaten fresh or canned. There are three standard types of canned prunes. Regular canned prunes are fully cooked in water, syrup, or their own juice. Nectar-style canned prunes are distinguished by their high drained weight, since they contain about one-third more prunes per unit volume. Moist-pack canned prunes are processed to 35 to 42 percent moisture and sealed in the can, with no liquid and no preservatives (CPB 1996).

U.S. per capita consumption of California prunes, by product category, is shown in figure 2.7. In general, U.S. per capita consumption of both dried prunes and prune juice has declined over time. U.S. consumption of dried prunes declined from over 1.1 pounds per person in 1949 to less than 0.4 pounds per person in 1978, and has remained at about 0.4 pounds per person since then, except for an increase in the late 1980s. As shown in table 2.2, U.S. per capita consumption of all dried fruits varies from year to year but it did increase through the 1980s and early 1990s, largely as a result of increased raisin consumption. Per capita consumption of fruit juices has generally increased over time, with most of the increase occurring in the noncitrus category, and more specifically, in apple juice. Prune juice consumption has decreased over time, and it now accounts for a minuscule portion of total fruit juice consumption (table 2.3 and appendix table A2.1).

2.3 Marketing Institutions for California Prunes

The California prune industry has developed a rather unique set of marketing institutions designed to improve producer returns. These institutions include federal and state marketing orders, as well as, marketing and bargaining cooperatives. Following is a short description of each of these institutions.

Prune Marketing Committee

California prune producers approved a federal marketing order for dried prunes in 1949 that continues today. This order, which includes provisions for mandatory minimum grade and size standards, market allocation, reserve pools, and research, is administered by the Prune Marketing Committee (PMC), with funding provided from a mandatory assessment on all

Table 2.2: *U.S. Per Capita Consumption of Dried Fruit (lbs. per year)*

Year	Prunes	Raisins	Other Dried Fruits	All Dried Fruits
1971	0.58	1.43	0.71	2.72
1972	0.49	1.04	1.07	2.60
1973	0.55	1.38	0.13	2.06
1974	0.51	1.29	0.85	2.65
1975	0.60	1.29	0.49	2.38
1976	0.53	1.28	0.79	2.60
1977	0.49	1.25	0.79	2.53
1978	0.43	1.10	0.94	2.47
1979	0.38	1.31	0.53	2.22
1980	0.43	1.46	0.45	2.34
1981	0.46	1.54	0.31	2.31
1982	0.42	1.52	0.56	2.50
1983	0.46	1.58	0.52	2.56
1984	0.39	1.90	0.43	2.72
1985	0.47	1.92	0.65	3.04
1986	0.44	1.83	0.69	2.96
1987	0.62	1.88	0.26	2.76
1988	0.58	2.07	0.43	3.08
1989	0.63	1.92	0.74	3.29
1990	0.97	1.80	0.43	3.20
1991	0.73	1.78	0.88	3.39
1992	0.58	1.62	0.89	3.09
1993	0.68	1.86	0.26	2.80
1994	0.71	1.72	0.82	3.25

Source: Adapted from USDA Economic Research Service. Food Consumption, Prices and Expenditures, 1996.

handlers. While it has no control over the acreage planted to prune trees, the PMC has some control over the quantity of prunes marketed, through use of a minimum size standard and a surplus set-aside. The minimum size standard is used each year, but the set-aside provision has not been used since 1974. The minimum size regulation states that a prune that falls through a 23/32 inch screen cannot be sold for human consumption. The effect of the "23" screen varies with crop size. In years with small harvests, the prunes are large, and relatively few prunes fall through the "23" screen, perhaps less than 3 percent. In years with large crops, the prunes are smaller, and the "23" screen may remove over 6 percent of the crop (Lindauer 1993). The "23" screen provides an incentive for growers to thin their prune orchards in years of abundant fruit set, and therefore reduces variation in yields.

The 100 count rule, which refers to the number of prunes in one pound of dried prunes, ensures that all prunes marketed as whole prunes are of a minimum size; smaller prunes are diverted into processed prune products. Under the 100 count rule, prune samples that weigh more than 1 pound per 100 prunes can be sold as whole dried prunes while those that weigh less than 1 pound per 100 prunes are processed into a prune product, such as prune juice, concentrate, or puree.

The California Prune Board

A state marketing order for prunes with provisions for promotion and research was approved by California prune producers in 1952. The objective of the California Prune Board (CPB), which is the administrative committee for the marketing order, is to increase worldwide demand for California prunes. The CPB administers domestic and international generic (nonbranded) programs that encompass advertising, sales promotion, public relations, and educational activities. The CPB also funds production and processing research.

<u>Promotion Strategies and Policies</u>: About 50 percent of the CPB's annual domestic budget is spent on television advertising (CPB, Annual Reports). Advertising can be made more effective by targeting certain groups, and CPB advertising has recently targeted women aged 45 or older who are light or non-recent users of prunes.

Sales promotional activities feature supermarket display contests in the United States and Canada. The display contests offer retailers travel and merchandise prizes for building winning displays. Generic point-of-sale display cards are provided, which tie in with the television advertising theme for prunes or with nutritional attributes of prune juice. The CPB also ties in with the National Cancer Institute's "5-a-Day" program, which recommends eating five servings of fruits and vegetables every day (Peterson 1994).

California public relations activities support the advertising themes and promote the use of pureed prunes as a substitute for butter, oil, or margarine in baking. For instance, a direct mail

Table 2.3: *U.S. Per Capita Consumption of Fruit Juices (gallons per year)*

Year	Prune	Total Noncitrus	Total Citrus	Total Juice
1971	0.12	1.13	4.59	5.71
1972	0.11	1.25	4.96	6.21
1973	0.07	0.96	5.07	6.03
1974	0.10	0.93	5.10	6.03
1975	0.08	1.00	5.60	6.61
1976	0.09	1.10	5.84	6.93
1977	0.11	1.06	5.94	6.99
1978	0.09	1.15	5.29	6.44
1979	0.10	1.44	5.32	6.77
1980	0.09	1.49	5.66	7.15
1981	0.09	1.73	5.69	7.42
1982	0.10	1.58	5.18	6.75
1983	0.08	1.82	6.56	8.38
1984	0.06	1.99	5.28	7.27
1985	0.07	2.16	5.57	7.72
1986	0.07	2.17	5.77	7.94
1987	0.07	2.19	5.98	8.17
1988	0.06	2.40	5.80	8.21
1989	0.07	2.35	5.34	7.69
1990	0.04	2.23	4.63	6.86
1991	0.04	2.53	5.36	7.89
1992	0.03	2.40	4.87	7.27
1993	0.04	2.45	5.91	8.37
1994	0.04	2.59	6.00	8.60

Source: USDA/Economic Research Service.

campaign to food-service operators offered low-fat brownies made with prunes, and brochures with low-fat recipes. The CPB also exhibits at trade shows and advertises in trade publications. Other public relations activities include recipe releases to newspaper food editors and supermarket consumer affairs directors, and visits to magazine food editors. The CPB also distributes one-ounce packages of pitted prunes at fitness events and in cereals.

The CPB also conducts international promotional activities, such as in-store demonstrations, publicity, trade education, and advertising. Support for international promotion increased sharply in 1987, and has increased in real terms since then. Approximately 50 percent of the funding for international promotional activities is provided by the USDA Market Promotion Program (MPP). The rise in export sales coincided with the participation of the California Prune Board with the MPP and its predecessors. In 1992, the CPB promoted the consumption of California prunes in 13 nations, but funding reductions in the MPP led the CPB to eliminate promotional programs in several of them. In 1994, the CPB conducted promotional campaigns in Germany, Italy, the United Kingdom, Japan, and Mexico (Peterson 1994).

Statistical Overview of Promotional Expenditures: CPB expenditures by category are shown in nominal dollars in figure 2.8a and in real 1995 dollars in figure 2.8b. CPB funding, in real dollars, for production research has remained roughly constant. In the 1990s, about 4 percent of the CPB budget was invested in production research. All CPB generic advertising and promotion support for California prunes was discontinued during 1975-78, when Sunsweet's management voted to eliminate the assessment for generic promotion, believing they could better promote Sunsweet's products on their own. The CPB reinstated a public relations program in 1979 and resumed generic advertising in 1980. Since the early 1980s, expenditures by the CPB in real dollars declined for advertising and increased for other domestic promotional activities. CPB expenditures on total promotional activities are shown in real and nominal dollars in figure 2.9. In both real and nominal dollars, total CPB expenditures on promotion have increased since the early 1980s.

While the Prune Marketing Committee and the California Prune Board are separate administrative bodies, established under different enabling legislation, they cooperate by using common office facilities and staff, and they also share industry data. The Dried Fruit Association of California inspects all prunes produced in California. This inspection service certifies the salable weight that the packer uses to pay the producer, determines the size, off-grade, and undersize of each lot, and collects data used by the industry to establish crop tonnage, inventory composition, and assessment fees.

Marketing Firms

The processing and marketing of California's annual prune crop is almost evenly divided between Sunsweet Growers, the industry's only marketing cooperative, and a group of independent growers and packers. Sunsweet members deliver their entire production to the cooperative, and their returns are based on the selling price of the processed fruit. Independent growers sell to independent packers or handlers on a contractual basis. All California prune producers and handlers pay mandatory assessments to support the generic promotional efforts of the California Prune Board. Members of Sunsweet also support substantial brand advertising of Sunsweet prune products. Under the prune marketing order, there is no assessment offset: if a packer such as Sunsweet promotes its own brand, there is no reimbursement of any of the assessment that the packer pays toward the generic program.

The Prune Bargaining Association

The Prune Bargaining Association (PBA) is a voluntary organization that represents about 40 percent of the independent growers (Giacolini 1993). Each year, the PBA negotiates with the independent processors to establish a selling price for its members. The price negotiated by the PBA influences the price received by all independent growers.

2.4 Trends in Factors Associated With Prune Demand

Several factors associated with prune consumption and the demand for prunes have been changing over time. These factors will be discussed briefly here, and their quantitative impacts on the demand for prunes will be examined in detail in the following sections of this report.

Age of the Population

The U.S. population is aging: the share of U.S. citizens 65 years old or older increased from 8.0 percent in 1949 to 13.0 percent in 1995 (Bureau of the Census 1996). This may or may not bode well for the prune industry. Currently available data indicate that older people consume more prunes per capita than younger people do (table 2.4). This pattern of consumption may be attributable to either an age effect or to a cohort effect. If it is an age effect, a person's preference for prunes increases as the person ages, and as today's young people become older, their prune consumption will increase. If it is a cohort effect, older people today consume more prunes perhaps because as children they ate more dried fruit relative to fresh fruit (since seasonal fresh fruit availability was limited, while dried fruit was available year-round). Therefore, having established patterns of dried fruit consumption as children, older Americans still consume relatively more dried fruit. If the cohort effect explains much of the higher

Table 2.4: *U.S. Per Capita Consumption of Dried Prunes in 1986, by Age Group*

Age group (years)	Per capita consumption (pounds)
18-24	0.67
25-44	0.62
45-54	1.00
55-64	1.52
> 65	1.95

Source: Dale et al. 1988

consumption of prunes by older people, then, holding other influences constant, per capita prune consumption can be expected to decline over time, since those who are young today are not developing similar preferences for dried fruit.

Changes in Household Structure

As recently as the 1950s, the predominant type of household included two adults and two children, with only the male head of the household working outside the home.[1] In the 1990s, single-person households are much more important, female heads of households are common, and nonworking spouses are now the exception more than the norm. These factors, combined with rising incomes and changes in technology available to households (such as microwaves and home freezers) and changes in food products available (including pre-prepared foods for home serving, and fast-food restaurants), have contributed to major changes in the way people live and, in particular, eat.

Importantly, the growth in per capita incomes can be expected to have led to an increase in the demand for food quality and services associated with food. The increased labor-force participation of women can be expected to have led to an increased demand for convenience in food, and for food with low preparation time (since the opportunity cost of working women's time is higher). These two factors can account for much of the major changes in food purchase patterns: a higher proportion of meals away from home, and a higher proportion of pre-prepared meals. Since prunes are ready-to-eat without additional preparation, the increased demand for convenience in food could increase the demand for prunes.

Fruit in the Diet

The average diet in the United States has been slowly changing to include leaner meats and more fruits and vegetables, as recommended by public health organizations. Per capita consumption of fresh fruit exhibited a steady declining trend from 1939 until the mid-1960s, when it began a gradual rise. Much of the decline and subsequent turnaround was attributable to the consumption of citrus fruits, particularly oranges, although noncitrus fruits, such as peaches and grapes, exhibited similar trends. The overall increase in per capita consumption of fresh fruits and vegetables continued slowly during the 1970s, and at a faster rate during the 1980s. Total per capita consumption of commercially produced fruits and vegetables was estimated at 678 pounds in 1994 (farm-weight basis), an increase of 20 percent over the quantity in 1970.

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[1] Alston et al. (1997) documented some of the changes in household structure and consumption patterns in the United States. This section draws heavily on that discussion. See also Blaylock and Smallwood (1986).

Overall, U.S. per capita consumption of processed fruit increased by 18.6 percent and per capita consumption of fresh fruit increased by 25.2 percent during the period from 1970 through 1994. There were, however, significant deviations by product category. Per capita consumption of fresh citrus, for example, decreased slightly, while per capita consumption of fresh noncitrus fruits increased by 41 percent (appendix table A2.3). Since fresh noncitrus fruits are believed to substitute for dried fruit (including prunes), the higher sales of fresh noncitrus fruit since 1970 may be associated with reduced purchases of dried fruit. On the other hand, increased demand for all fruits is expected to increase the demand for dried fruit.

U.S. per capita consumption of dried fruit declined by one-half from 1920 to 1980 (USDA 1979). In the 1920s, fruit was consumed fresh mainly during the harvest period, since fresh fruit was typically not available, and when available, it was prohibitively expensive during the off-season. Technical advances in varieties, production, storage, shipping, and the development of new areas of production now make fresh fruit available throughout the year at reasonable prices. The increased supply of fresh fruit on a year-round basis may have reduced the demand for dried fruit. Despite the increased consumption of fresh fruits, however, U.S. per capita consumption of all dried fruit has also increased since the late 1970s (appendix table A2.4).

Baking Use of Prunes

Research on new uses for prunes has found that prunes can be used as a fat substitute in baked goods. The use of prune puree, for example, allows consumers to reduce the fat in baked goods by 60 to 90 percent. Other benefits include reduced cholesterol, improved preservation, and improved nutrition. Prune puree, prune paste, and diced prunes are now being marketed as cooking ingredients in baked goods, and are promoted as fat substitutes. The share of food technologists who use prunes in baking increased from 10 percent in 1992 to about 27 percent in 1996 (CPB September 1996). Given the current emphasis on reducing fat consumption in human diets, this could provide an important boost to the demand for prunes. Prune puree, however, still constitutes less than 2 percent of California domestic prune shipments (appendix table A2.5).

2.5 Concluding Comments on Supply and Demand Trends

The California prune industry has experienced significant changes in both supply and demand over the past 50 years. The bearing acreage of prunes has trended down, but this was largely offset by increasing average yields. As a result, total California prune production has varied significantly from year to year, but without either an upward or a downward trend. On the demand side, there have been significant trends in crop utilization, product form, and per capita consumption. The amount and share of the annual crop shipped to domestic markets decreased over time, while exports increased to over 40 percent of the crop. During the same time frame, the proportion of dried prunes sold in the pitted form increased from less than 1 percent to over 80 percent, as a result of new and improved technology for pitting. Accompanying these changes were significant reductions in U.S. per capita consumption of dried prunes and prune juice.

A number of factors may have affected the demand for prunes over time. Those mentioned include the advertising and promotion programs conducted by the CPB, as well as the traditional demand shifters of income, population, and prices of competing products. Other potentially important factors include (1) changing demographics, especially the increasing average age of the U.S. population and the changing household structure, (2) health and diet concerns that have increased the demand for fruits and vegetables, (3) the year-round availability of fresh fruit, and (4) new and improved products and uses (pitted prunes and prunes as a fat substitute in baking). However, since many of the factors have been changing at the same time, it is difficult to isolate cause and effect. The following sections detail the specification and estimation of aggregate demand relationships for prunes.

3. ACCOUNTING FOR CHANGES IN AGGREGATE U.S. PRUNE CONSUMPTION

In this section, we specify demand models for California prunes and report the results from estimating these models using monthly data covering the period from September 1992 through July 1996, and annual data for 1949 through 1995. These econometric models use per capita quantities of dried prunes in the United States. Important related distinctions concern the market level (e.g., farm versus retail) and whether the quantity is all prunes for all destinations (as farm-level quantities are) or for domestic consumption only (as retail quantities are). Section 3.1 covers general theoretical aspects, section 3.2 covers the monthly models, and section 3.3 covers annual models

3.1 Aggregate Domestic Demand Models, Theoretical Considerations

Aggregate per capita demand models provide parameters that can be used to estimate gross and net benefits to the industry from promotion. Once the model is estimated econometrically, we use the estimates from to analyze the effect that a change in promotion would be likely to have on per capita consumption. Economic theory is used as a guide in the specification of the model, in the identification of variables that are used to explain changes in consumption patterns, and in the interpretation of the results from estimation.

A Consumer Demand Model

Suppose we use Q_t to represent the per capita quantity of prunes (of uniform quality) demanded by a representative consumer during a particular year, t. The theory of consumer demand suggests a model in which the quantity demanded, Q_t, depends on the corresponding price of prunes, PP_t, the prices of all other goods that are substitutes or complements for prunes (such as other dried fruits or laxatives, and fresh fruits, in particular), PS_t, and total money income or expenditure on all goods, EXP_t. This model can be expressed as

$$Q_t = f(PP_t, PS_t, EXP_t). \tag{3.1}$$

To make this model operational, one must specify a particular functional form for $f(.)$—for instance, a linear functional form, which we use later. In this model, we would expect the own-price effect to be negative (a negative coefficient on PP_t). The cross-price effects (the coefficients on other prices, PS_t) can be positive or negative, but are expected to be predominantly positive, especially for close substitutes, and the income effect (the coefficient on EXP_t) is probably positive and in the range for a normal good, corresponding to an income elasticity of demand for prunes between 0 and 1. In other words, an increase in the price of prunes would lead to a decrease in prune consumption, while an increase in the price of a substitute or in total money income would lead to an increase in prune consumption.

In addition, the theory of consumer demand implies that the demand equation should be homogeneous of degree zero in money income and prices—doubling money income and all prices should leave consumption unaffected, since nothing real has changed. This homogeneity condition is commonly imposed by dividing all of the prices and income by a general price index, such as the consumer price index (CPI), thereby expressing all of the monetary variables in the demand equation in *real* terms (denoted RPP_t, RPS_t, and $REXP_t$). The resulting model is

$$Q_t = f(RPP_t,\ RPS_t,\ REXP_t). \tag{3.2}$$

Both of these demand equations (equations 3.1 and 3.2) implicitly assume constant tastes and preferences for prunes. In order to accommodate changes in preferences arising from promotion or anything else that may affect demand (such as demographic characteristics of the consumer), the model can be augmented with other *demand shift variables*.[2] Clearly, promotion is one such variable. To obtain reliable estimates of the influence of the factors that are of most importance for the present study—in particular, the responsiveness of demand to price and promotion—it is necessary to take into account the influence of other demand shift variables as well. Otherwise, there is a risk that the effects of omitted shifters will be attributed falsely to the variables included in the model.

In a model of consumer demand for California prunes, appropriate shift variables can be included to represent the effects of such things as (a) increased consumer health consciousness and a rising consumer interest in natural foods; (b) other demographic changes, such as changes in the age structure of the population (likely to be especially important for prunes, since they are relatively heavily consumed by older people), a higher rate of labor-force participation by women, changes in the ethnic composition of the population, and the fact that more meals are eaten away from home; (c) generic promotion by the California Prune Board, brand promotion by Sunsweet and others, and other changes in merchandising expenditures, and (d) changes in the quality of California prunes.

To deal with all of these individual variables explicitly in a model is impossible, given our limited dataset and the difficulty of identifying their individual effects, when many variables change smoothly, together, over time. Instead, we focus on those shift variables for which we think the effects are likely to be the most important. Thus, we include four types of shift variables including (a) where possible, a variable to represent the changing age structure of the population; (b) the quantity of promotion, represented by the total—not per

[2] Blaylock and Smallwood (1986) document some of the general trends in consumer demand for food that

capita—promotional expenditures[3] of both the California Prune Board and Sunsweet, expressed in real terms by dividing expenditures by the CPI, $RPROCPB_t$ and $RPROSUN_t$, respectively; (c) a linear time trend variable, $TIME_t$, included to represent the effects of other trends, as described above, that are not being modeled explicitly; and (d) quarterly intercept dummy variables (SPR_t, WIN_t, and SUM_t), to reflect seasonal shifts in demand in the monthly demand models. Note that Fall is the base season—the estimated coefficients for SPR_t, WIN_t, and SUM_t show the change in demand from the Fall base season.

Incorporating the shift variables leads to an augmented model of demand, as follows

$$Q_t = f\,(RPG_t, RPS_t, REXP_t, RPROCPB_t, RPROSUN_t, SUM_t, WIN_t, SPR_t, TIME_t) \qquad (3.3)$$

The effects of the demand shift variables are not as easy to predict as those of the more conventional ones. Promotion is expected to have an unambiguously positive effect on demand, but, even then, only if it has been successful in increasing demand for prunes; otherwise, this variable would have no effect on demand. The effect of the time trend is likely to be negative, reflecting a general shift of consumer demand away from prunes over time. It is expected that per capita consumption of prunes increases with increases in the fraction of the population in older age categories, but it is likely to be difficult to separate age effects from cohort effects (indeed, as noted above, an important question is whether declining per capita consumption is an age effect, reversible as the population becomes older again, or a cohort effect, and not reversible).

Horizontal and Vertical Market Linkages and their Implications

The above models refer to final consumer demand. Often, however, in empirical work, we use data that relates to the *derived* demand at the farm or wholesale level, which is derived from the final consumer demand and the economic and technological characteristics of the intermediate functions between the final consumer and the market level being studied (e.g., the marketing, processing, and transportation functions). Therefore, in addition to variables indicated by the theory of consumer demand, derived demand functions may also include variables representing processing costs, labor costs, and so on. In the models presented here, the consumer price index plays a dual role as a general index of the prices of substitutes (other than those identified in the model below) in consumption for prunes, and as an index of the prices of marketing inputs. Derived demand equations are generally expected to be less price-responsive (less elastic) than retail demand equations.

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may be reflected in shift variables of these types.

[33] The choice of whether to include promotion in per capita terms or in total was discussed by Alston et al. (1997).

Another aspect of market structure we must consider is one of horizontal linkages. These include linkages between the U.S. market and international markets for U.S. prunes, and linkages among markets for alternative end-uses for U.S. prunes. When we study the market for dried prunes, we are considering only a subset of the total market for U.S. prunes; when we study the domestic market we are studying only a subset of the total world market for dried prunes. This can be thought of in terms of residual supply and demand. In practice, we can study the domestic demand for dried U.S. prunes independently of the markets for other uses of U.S. prunes without experiencing any econometric problems. However, when we want to simulate changes in domestic demand for U.S. dried prunes, we must recognize that the markets are linked, and a significant element of the market response to an advertising-induced increase in domestic consumption of dried prunes will be a reallocation of prunes from other uses; either other domestic uses or exports. These horizontal linkages are captured through a modification of the effective supply of dried prunes to the U.S. market, which is the residual from total supply and demand for other uses. The issues of residual supply and demand and derived demand are discussed at greater length by Alston et al. (1995).

3.2 Aggregate Monthly Domestic Demand Models[4]

This section contains a summary of the regression models used to estimate the effects of promotion on monthly per capita prune consumption in the United States. It should be noted that the models in section 3.2 concern retail sales only. The models studied here indicate that promotional expenditures have a statistically significant, positive effect on monthly prune consumption at the retail level. Before presenting the demand models and the empirical results, we give an overview of the data and data sources for these models.

Data

The time period for this part of the study was from September 1992 through July 1996, comprising 51 observations with lengths of four weeks each. The monthly regressions presented here are based on data collected from four sources, as described below.

Quantities: The data describing the quantities of dried prunes consumed in the United States come from Infoscan IRI retail market profiles representing U.S. consumption based on 64 cities/regions in the United States. These data were provided by Sunsweet. We used "total" prune consumption over this period, which was the total of all brands sold in retail stores. During this period, retail sales accounted for approximately 30 percent of all prune sales (CPB

[4] Throughout this section, we use the term "monthly" to refer to the length of the observation period, where in reality, the observations are four weeks long.

1997). The quantities were converted into pounds per capita using an estimate of the U.S. midyear population (International Monetary Fund). We converted this population statistic into population per observation period using a growth formula provided by the U.S. Census Bureau. Monthly per-capita consumption of prunes, shown for the observation period in figure 3.1, averaged 0.015 pounds with a standard deviation of 0.002.

Prices: The prices used in the demand models were the average retail price ($/pound) of prunes purchased and the average price of dried fruit other than prunes ($/pound) purchased from retail food stores.[5] These prices also came from the Infoscan IRI data and were converted into 1996 dollars using the consumer price index (International Monetary Fund). Deflation by the CPI has the effect of treating an aggregate of all other goods as a general substitute for prunes. It would be desirable to represent the effects of close substitutes explicitly, by including a separate variable for each one, but data constraints and likely statistical problems (such as multicollinearity) mean that we cannot include too many other prices; probably no more than one. While it is difficult to identify a particular index to represent those goods that are close substitutes for prunes, the models presented in this section use the real price of an aggregate of other dried fruit as RPS_t.

It must be stressed that there was very little price movement for prunes and other dried fruit during the observation period used for the monthly demand models. Deflating the prices by the CPI dampened this movement even further. Over the observation period, the average real price of prunes was $2.18 per pound per month (it ranged from $2.05 to $2.26 per month), and the average real price of other dried fruit was $2.39 per pound per month. The standard deviations were 0.045 and 0.042 respectively. Thus, we are attempting to correlate a consumption variable with price variables that simply did not move very much. A data set covering a longer time period, with more variation in prices, might be expected to provide improved estimates of price effects on demand.

Promotion: Promotion includes generic promotional expenditures by the California Prune Board and brand promotion by Sunsweet Growers, the largest private promoter of dried prunes. There is little or no branded promotion (besides display units and other trade promotions like "buy one get one free") by other packers, and Sunsweet is the only packer to advertise its prunes nationally. The aggregate monthly promotion variables (*PROCPB* and *PROSUN*) each include monthly sales promotion and monthly television advertising.

PROMOCPB is monthly sales promotion expenditure by the California Prune Board for prunes. Specifically *PROMOCPB* is the sum of the following budgetary items: Coupon Program, Public Relations, Sampling, and Merchandising/Sales Promotion (Source: *California Prune Board*

[5] Prices of dried fruit excluding raisins, and prices of raisins alone were also considered, but neither is included in any of the models in this section.

Generic Monthly Program Evaluation for crop years 92/93-95/96). Throughout this section, "Sales Promotion" refers to the sum of these budgetary items. All figures were converted from monthly into monthly data using daily averages for each month, in order to match the Infoscan IRI quantity and price series. *PROMOSUN* is sales promotion expenditures by Sunsweet Growers for prunes. *PROMOSUN* consists of monthly total dried fruit promotion converted from monthly data into monthly data using average daily expenditures for each month (Source: *Sunsweet Growers Monthly Advertising and Merchandising Expenses* for crop years 92/93-95/96).

ADCPB is television advertising expenditure for the specific observation point, as billed to the CPB. Unlike the sales promotion expenditures, which came from the crop-year budgets, these data accurately reflect the timing of television advertisements. The figures were converted from monthly expenditures to monthly expenditures using daily averages (Source: CPB). *ADSUN* is television advertising expenditures as billed to Sunsweet. These data, which were reported on a weekly basis, were summed to provide monthly figures for the observation period (Source: Sunsweet Growers).

Finally, aggregate promotion variables were constructed for CPB and Sunsweet which include both sales promotion and television advertising: *PROCPB = ADCPB + PROMOCPB* and *PROSUN = ADSUN + PROMOSUN*, expressed in millions of dollars.

The timing of sales promotion expenditures may involve problems. As discussed above, only the two television advertising variables *ADCPB* and *ADSUN* reflect accurately when advertising was seen by viewers. The two sales promotion variables are off by an indeterminate amount, since they came directly from the CPB's and Sunsweet's accounting records. The problem with these two variables is that they aggregate a variety of important sales promotion expenditures (coupon payments, public relations, sampling, and merchandising/sales promotion) whose timing varies. Thus, while the *AD-* variables reflect dollar figures corresponding to the actual timing of promotion (e.g., television commercials), the *PROMO-* variables do not. Since some promotional expenses are paid when the promotion occurs, while others are paid ahead of time, and still others are paid after the promotion is over, it is not clear whether these variables should be lagged or not in the regressions. Ultimately, it was decided to use the variables as presented in the budgets.

Promotional expenditures were expressed in real (or quantity) terms to reflect the view that, if the CPB's and Sunsweet's budgets doubled, and the cost of promotion doubled as well, there would be no real change in the amount of promotion undertaken. Ideally, to do this, we would deflate promotional expenditures by an index of the unit cost of promotion. Lacking such an index, we assume that promotion costs rise with prices generally, and use the CPI to deflate promotional expenditures.

Table 3.1: *Description of Variables in the Monthly Demand Model*

Variable	Definition	Units	Data Source
$TIME_t$	"Month"	One observation is four weeks long.	
Q_t	"Monthly" per capita consumption of dried prunes in the U.S. from the week ending September 6, 1992 to July 7, 1996. Recall, one "month" here is exactly four weeks long.	pounds of dried prunes per person per month	Prune Consumption from Infoscan IRI retail market profiles. U.S. population from International Financial Statistics
RPP_t	Real average retail price of prunes.	real dollars (August 1996=1) per pound of processed prunes	Prices came from Infoscan IRI and were deflated by CPI data from International Financial Statistics
RPS_t	Real average retail price of all other dried fruit.	real dollars per pound	Prices came from Infoscan IRI and were deflated by CPI data from International Financial Statistics
$REXP_t$	Real, average, quarterly per-capita private domestic consumption expenditures.	real dollars per person per quarter	International Monetary Fund
$RPROCPB_t$	Aggregate real promotional expenditures by the California Prune Board for dried prunes in the U.S. market.	real dollars per month	California Prune Board.
$RPROSUN_t$	Aggregate real promotional expenditures by Sunsweet for dried prunes in the U.S. market.	real dollars per month	Sunsweet Growers.
WIN, SPR, SUM	Winter, Spring, and Summer dummy variables respectively.		

Notes: *RPS* was broken down into its components (raisins, *RPR*, and other dried fruit, *RPF*) which were used as added instruments in the 2SLS model estimated in this report.

Table 3.2: *Summary Statistics of the Variables in the Monthly Demand Model*

Variable	N	Mean	Standard Deviation	Minimum	Maximum
Q	51	0.015	0.002	0.012	0.020
RPP	51	2.179	0.045	2.054	2.264
RPS	51	2.394	0.042	2.305	2.527
RPR	51	2.010	0.041	1.916	2.067
RPF	51	4.599	0.363	3.984	5.258
REXP	51	18,691	499.52	17,785	19,483
RPROMO	51	1.512	0.483	0.516	2.397
TIME	51	26	14.866	1	51

Notes: In this table, $RPROMO = RPROCPB + RPROSUN$ represents total monthly promotion in millions of dollars (aggregated to maintain Sunsweet's confidentiality). *RPR* and *RPF* are the real prices of raisins and other dried fruit, respectively. These were used in the 2SLS model.

Other Variables: A total expenditure variable was also included. As monthly data were not available, the expenditure variable was based on quarterly data on total private domestic consumption expenditures (billions of dollars) for the United States, taken from the *International Financial Statistics* published by the International Monetary Fund. These figures were then deflated by a quarterly CPI (August 1996 = 1.00), to put them in real terms, and divided by a quarterly estimate of U.S. population, to put them in per capita terms. The annual average of this per-capita income variable was $18,690.98 and its standard deviation was $494.60.

A time-trend variable was also used in some of the demand models. Over the period of study, there has been a slight decrease in per capita prune consumption, so we might expect the coefficient on the trend variable to be negative, if this decline in consumption is not attributable to the other variables in the model. Conversations with CPB staff suggested that prune consumption varies seasonally. To investigate this possibility, three quarterly dummy variables (*WIN* = Winter, *SPR* = Spring, and *SUM* = Summer) were specified, with the Fall quarter (October, November, December) used as the base season. The seasonal variables are equal to one for each month during a given season and zero otherwise. When the four-week period for a particular observation spans two seasons, it is assigned to the season that applies for the majority of days in the 4-week period.

Table 3.1 summarizes the definitions of the variables used in the monthly demand models. A complete listing of the data, as used in the regressions, is provided in appendix table A3.1. Summary statistics for the monthly demand variables are included in table 3.2.

Estimation Results and Selection of the Preferred Monthly Models

In this section, we present regression equations that represent the monthly demand for prunes in the United States for the period spanning the months September 1992 through July 1996. Other regression equations are also included for comparison, and as indicators of the robustness of certain aspects of the preferred models. Initially, the models were estimated by ordinary least squares (OLS).

Promotion Variables and Lags: To investigate the timing issues with the sales promotion variable, several models that included lagged promotion variables with a variety of polynomial restrictions on the lag structure were tested. These models were all unsatisfactory, and they are not presented here. Further, we decided to use the aggregate *PROCPB* and *PROSUN* variables instead of disaggregating each of them into *AD* and *PRO*.[6]

[6] When *AD* and *PRO* were included in a linear model, their coefficients were essentially equal. Thus, there was no information gained by separating *PROCPB* or *PROSUN* into their components and we would lose degrees of freedom in doing so.

Functional Form Choice: The functional form for the demand equation must be specified, in order to estimate an econometric demand model. The choice of the functional form for the demand equation, which is guided by diagnostic tests, is important because it can influence the results of the econometric estimation (e.g., see Chalfant and Alston, 1988; Alston and Chalfant, 1991). In what follows, we focus on the results from a demand equation that is linear in all the variables, except that we include the square root of promotion instead of the level of promotion; the *square-root* model. This model allows diminishing marginal returns to promotion.[7] Models of this form were used to study table grape promotion by Alston et al. (1997).

Unlike Alston et al. (1997), we have more than one category of promotion expenditure, and, in particular, we wish to include separate variables representing generic promotion by CPB and brand promotion by Sunsweet. Accordingly, we consider two types of models that include promotion variables in square-root form. The first type consists of two models that include the square root of all promotion. Model 3.4a allows the marginal effects of CPB and Sunsweet promotion expenditures to differ, while model 3.4b sets the promotion parameters in equation 3.4a equal, so that the marginal effects of CPB and Sunsweet promotion expenditures are forced to be the same.

$$Q_t = b_0 + b_{PP}RPP_t + b_{PS}RPS_t + b_{EXP}REXP_t + (b_{CPB}RPROCPB_t + b_{SUN}RPROSUN_t)^{1/2}$$
$$+ b_{SPR}SPR_t + b_{WIN}WIN_t + b_{SUM}SUM_t + b_T TIME_t + e_t \,. \qquad (3.4a)$$

$$Q_t = b_0 + b_{PP}RPP_t + b_{PS}RPS_t + b_{EXP}REXP_t + b_{PRO}(RPROCPB_t + RPROSUN_t)^{1/2}$$
$$+ b_{SPR}SPR_t + b_{WIN}WIN_t + b_{SUM}SUM_t + b_T TIME_t + e_t \,. \qquad (3.4b)$$

We also consider two other models based on separate square roots of promotion expenditures. In equation 3.4c, the marginal effects of CPB and Sunsweet promotion expenditures are allowed to differ:

[7] A consequence of including the square root of promotion, rather than the quantity of promotion, is that this transformation imposes diminishing marginal returns on the demand response for promotion; the linear model is characterized by constant marginal returns. The marginal return to promotion refers to the incremental benefit from increasing promotional effort by a small amount, say one dollar. Diminishing marginal returns means that each incremental dollar spent on promotion brings forth a smaller benefit than the last. It is preferable to have a structure that imposes (or at least permits) diminishing returns for two related reasons. First, it would be uneconomic to choose quantities of promotion in a range of constant or increasing marginal returns. Second, in order to solve for optimal promotion, we require a model with diminishing returns. Similar conditions do not apply to the other variables in the model, since they are not chosen by the prune industry.

$$Q_t = b_0 + b_{PP}RPP_t + b_{PS}RPS_t + b_{EXP}REXP_t + b_{CPB}(RPROCPB_t)^{1/2} + b_{SUN}(RPROSUN_t)^{1/2}$$
$$+ b_{SPR}SPR_t + b_{WIN}WIN_t + b_{SUM}SUM_t + b_T TIME_t + e_t \, . \qquad (3.4c)$$

A special case of equation 3.4c is given by assuming that Sunsweet promotion has no effect on the total market for prunes. This is shown by equation 3.4d. Note that equation 3.4d can also be seen as a special case of equation 3.4a by setting $b_{SUN} = 0$.

$$Q_t = b_0 + b_{PP}RPP_t + b_{PS}RPS_t + b_{EXP}REXP_t + b_{CPB}(RPROCPB_t)^{1/2}$$
$$+ b_{SPR}SPR_t + b_{WIN}WIN_t + b_{SUM}SUM_t + b_T TIME_t + e_t \, . \qquad (3.4d)$$

We can test models 3.4b and 3.4d as special cases of model 3.4a, and model 3.4d can also be tested against 3.4c. Models 3.4a and 3.4c, however, are not nested as special cases, and cannot be tested against one another using conventional nested tests.

In all of these models, the *b* coefficients are multipliers that, holding the other independent variables constant, translate changes in the prices and other right-hand-side variables into changes in quantities consumed. For the promotion variables, *RPROCPB* and *RPROSUN*, however, the multipliers translate changes in the square-root transformations of the underlying variables into changes in quantities consumed. Thus, the multipliers here do not represent partial derivatives for the promotion variables. e_t represents residual changes in per capita quantities consumed that are not accounted for by changes in the right-hand-side variables. e_t is sometimes referred to as the "error" term, since it can be thought of as the error in predicting Q_t using only the right-hand-side variables. These residuals are typically assumed to be normally distributed random variables, with an expected value of zero and a constant variance.

Evaluating the Structure of the Model Holding Promotion Constant

The strategy for estimation was first to evaluate the structure of the model holding constant the specification of the promotion variables. To do this, we used a single aggregate promotion variable (i.e., the model in equation 3.4b). This model, which performed well, was not rejected by subsequent tests. The second step was to explore the effects of different specifications of promotion variables, holding constant the rest of the model.

We estimated the model in equation 3.4b and then examined the estimated coefficients to see whether they satisfied our expectations, based on the theory laid out above, and, at the same time, examined the residuals to see whether their behavior was consistent with the conventional econometric assumptions. In addition, diagnostic tests were applied to see whether the validity of the model and its parameters could be rejected by the results from alternative models, using alternative functional forms, and making different assumptions about whether prices and promotion are statistically exogenous.[8] Only if a model passes all of these tests—that is, it is consistent with economic theory and our expectations about the signs and sizes of the coefficients, has well-behaved residuals, and is not rejected by an alternative specification—can we confidently take the next step and use the estimated model to simulate alternative market scenarios.

The results from estimating the complete model, as specified in equation 3.4b, are shown in the first column (column 1) of table 3.3. The other five columns (columns 2 through 6) report the results of OLS regressions, based on equation 3.4b, that were derived by restricting various combinations of the coefficients on the price of substitutes, total expenditure, and the time trend to be zero. Note that it was difficult to derive estimates for all of the hypothesized economic relationships. The effects of price movements (and estimates of the own-price elasticity of demand) were hard to determine, because there was very little price change for prunes and other dried fruit during the time period under consideration. In addition, income effects were difficult to distinguish from the effects of other variables characterized by smooth trends over time. These patterns in the exogenous variables meant that several of the estimated coefficients were not statistically significant.

Restricting the insignificant coefficients to zero (by dropping the corresponding variables from the regression) could have undesirable consequences for the interpretation of the remaining coefficients. For instance (as will be seen in the models presented later), if the time-trend variable is left out of the regression, the price variable "picks up" the declining trend in prune consumption and, thus, too much importance is given to the price variable (which can be seen in the elasticities greater than one in absolute value when trend is dropped from the regression). Since it is not clear that other dried fruits substitute for prunes, and other dried fruit prices showed little movement during this period, models were tried excluding these "substitute" prices. Further, income or total expenditure was not expected to have much effect on prune consumption because of the short time-period covered, and only entered the model in a statistically significant way when trend was not included in the regression. Since the income

[8] If either promotion or price is *endogenous*, in the sense that their values are affected by changes in quantities consumed, as well as causing changes in quantity consumed, the econometric model may suffer from *simultaneous-equations bias*. Such bias, if it exists, results from correlation of an explanatory variable with the error term, and may lead to a misstatement of the demand response to changes in price or promotion. The direction of such bias is hard to predict in the absence of a specific alternative model in which these variables are simultaneously determined.

effect was negative if a trend variable was left out of the model, the strong suspicion is that *REXP* simply took the place of the trend variable. Thus, *REXP*, too, was left out of several regressions.

Because of scaling, the coefficients on the promotion variable appear very small (the dependent variable, per capita consumption per month, averaged 0.015 pounds while the square root of total expenditures on promotion averaged $1,212.60). Therefore, a more useful statistic is the elasticity measure, which accounts for the relative size of the variables by using percentage changes. Each of the elasticity coefficients is calculated as the percentage change in per capita prune consumption from a one percent change in the independent variable of interest. Thus, an elasticity of 0.2 means that a 10 percent increase in the independent variable leads to a 2 percent increase in prune consumption.

Regression results for variations on model 3.4b are displayed in table 3.3. In this table, the elasticities are displayed in brackets beneath the coefficient estimates, and have been calculated at the means of the economic variables. The figures in parentheses are t-statistics. The Adjusted R^2 statistic indicates the proportion of the variation in consumption that has been accounted for by the independent variables included in the equation. The R^2 statistics range from 69.2 percent in model 2 to 81.1 percent in model 1 in table 3.3. Finally, the Durbin-Watson statistic is used to test for the presence of first-order autocorrelation, which was statistically significant only in model 2 in table 3.3.

As mentioned above, the period of study was one of very little price movement. Not surprisingly, it was difficult to find significant effects on quantity demanded from changes in prices. For all the models presented in table 3.3, only the model 2 had a statistically significant estimate of the demand response to price.[9] In model 2, the own-price elasticity of demand for prunes is about -1.8 at the mean of the sample data, a surprisingly large estimate of the elasticity. Comparatively, a study of the U.K. market suggested a price elasticity of -0.7 for the total market and -1.23 for Sunsweet (Thorogood 1994). Model 2, however, does not include a time trend, a price of substitutes, or an income variable. We suspect this is a misspecification and causes the regression to attribute a declining trend in the consumption of prunes to exaggerated price effects. When a trend is included, as in models 4 and 5 of table 3.3, a much smaller own-price elasticity is obtained.

Notice that the coefficient on the price of substitutes, included in models 1 and 3 of table 3.3, is statistically significant but negative, which is contrary to expectations. Other dried fruit prices and prune prices moved closely together during this period. A measure of income, or total expenditure, appears in models 1, 3, 5, and 6. As discussed above, when trend is not

[9] Unless otherwise noted, all statements regarding statistical significance are based on a 95 percent confidence level.

Table 3.3: *Coefficient and Elasticity Estimates from the Monthly Demand Models*

Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.015	0.037	0.068	0.019	0.049	-0.028
	(0.283)	(4.148)	(6.470)	(2.340)	(6.209)	(-0.551)
RPP	-0.003	-0.013	-0.005	-0.004	-0.006	-0.003
	(-0.794)	(-3.185)	(-1.382)	(-1.213)	(-1.568)	(-0.743)
	[-0.437]	[-1.824]	[-0.687]	[-0.642]	[-0.822]	[-0.428]
RPS	-0.009		-0.010			
	(-2.228)		(-2.541)			
	[-1.433]		[-1.591]			
$(RPROMO)^{1/2}$	0.535E-2	0.421E-2	0.539E-2	0.523E-2	0.522E-2	0.519E-2
	(6.339)	(4.046)	(6.384)	(5.969)	(5.848)	(5.901)
	[0.214]	[0.168]	[0.215]	[0.209]	[0.209]	[0.207]
REXP	0.129E-5		-0.136E-5		-0.153E-5	0.247E-5
	(0.505)		(-4.248)		(-4.585)	(0.946)
	[1.585]		[-1.676]		[-1.879]	[3.036]
WIN	0.002	0.001	0.002	0.001	0.002	0.001
	(3.797)	(2.620)	(4.376)	(3.358)	(3.446)	(2.990)
SPR	0.002	0.002	0.002	0.002	0.002	0.002
	(3.862)	(3.013)	(4.510)	(4.400)	(4.494)	(3.699)
SUM	-0.0005	-0.001	-0.0003	-0.0005	-0.0004	-0.0006
	(-1.105)	(-1.872)	(-0.826)	(-1.188)	(-1.106)	(-1.418)
TIME	-0.0001			-0.535E-4		-0.0001
	(-1.047)			(-4.819)		(-1.544)
Adjusted R^2	0.811	0.692	0.810	0.794	0.787	0.793
Durbin-Watson	2.114	1.546	2.115	2.365	2.390	2.291

Notes: t-statistics are in parentheses, elasticities (at means) are in brackets. Elasticities in the row $(RPROMO)^{1/2}$ are the elasticities of demand with respect to *RPROMO*. Model 1 is equation 3.4b in the text.

included but income is, the income variable may be acting like the trend variable; hence the negative sign on the income coefficient in models 3 and 5. In models 1 and 6, which include trend, the income effect is not statistically significant. While it may be the case that income effects are important in determining prune demand (especially in a monthly demand model), it is more likely that income and trend are collinear, as both are increasing over the observation period, and it is difficult for the regression estimation procedure to distinguish the separate effects of the two variables.

Seasonality is present in all of the estimated monthly demand models. Using the Fall season as the base, we see that the coefficient estimates for Winter and Spring are significantly positive, whereas the coefficient for Summer is insignificant. From these results, holding price and other factors constant, one concludes that prune demand is significantly greater in Winter and Spring than in Summer or Fall.

An examination of prune consumption over the 1990s shows a decline in demand, so it was expected that the time-trend coefficient would be negative. In fact, the trend coefficient was always negative. For the models presented in table 3.3, trend is significant in model 4 and insignificant in models 1 and 6, with the latter results probably due to the high correlation of trend with income.

The promotion variable was statistically significant at the 99 percent confidence level in each of the models in table 3.3. In addition, except for model 2 (which excluded the price of substitutes, income, and trend), the estimated coefficients on promotion and corresponding elasticities were very stable across model specifications.

Model 1 is preferred over each of the other models in table 3.3. In model 1, the price coefficient is negative, and of plausible magnitude (although not statistically significantly different from zero), with an elasticity at the mean of -0.4. The estimated coefficient on total per capita expenditure is positive, but not statistically significant. The corresponding elasticity of demand with respect to income is 1.6, which is larger than expected. The statistically significant cross-price elasticity is -1.4. This suggests that other dried fruit is a complement rather than a substitute for prunes, or that the price of other dried fruit may be acting as a proxy for other variables. The elasticity of demand with respect to promotion in the preferred model is 0.21. (This elasticity was also 0.21 in all of the other models in table 3.3 except model 3, which was the least acceptable of all.)

Diagnostic Tests

As noted above, differences between the predictions from the model and actual per capita consumption, e_t, are referred to as errors or residuals. Diagnostic tests can be used to evaluate the properties of the residuals. Evidence that the residuals do not satisfy certain theoretical properties may be interpreted as an indication of model misspecification, such as having omitted relevant explanatory variables or having used the wrong functional form. The *DIAGNOSTIC* procedure in SHAZAM was used to perform a range of tests for heteroskedasticity and omitted variables, and the RESET test (Ramsey, 1969; Maddala, 1992; White et al, 1990) for misspecification.

Missing Variables: In a misspecified model, or a model with significant missing variables, the effects of missing variables are relegated to the error term, and this can cause several estimation problems. We tried three variants of Ramsey's specification error test (RESET), in which predictions from the model, $\hat{Q}$, were added to three additional regressions of the dependent variable on the independent variables. First, the model is re-estimated with $\hat{Q}^2$ added, then with both $\hat{Q}^2$ and $\hat{Q}^3$ added, and, finally, with $\hat{Q}^2$, $\hat{Q}^3$, and $\hat{Q}^4$ added. In each case, the statistical significance of the added regressors was tested. Passing the RESET test requires an insignificant test statistic for all three tests: no evidence of misspecification. Failing the RESET test would suggest that the model should be rejected, but the test itself would not imply any particular alternative. In model 1 in table 3.3, these test statistics were not statistically significant; hence, there is no statistical evidence of misspecification.

Heteroskedasticity: Ordinary least squares (OLS) presumes that the variance in the error term is constant across observations. If this is not the case (i.e., if heteroskedasticity is present), then OLS yields biased estimates of the standard errors for the coefficients. Although the coefficient estimates themselves would be unbiased, the t-ratios discussed above and presented in table 3.3 would be biased, invalidating our hypothesis tests. Several tests for heteroskedasticity were run on model 1 in table 3.3. Of seven tests performed, the conclusions were mixed: the hypothesis of no heteroskedasticity rejected in four of the seven tests.

Taking the results of these tests as evidence of heteroskedasticity, we re-estimated model 1 with an alternative set of standard errors obtained using White's (1980) heteroskedasticity-consistent covariance matrix. For large enough samples, these estimates allow confidence in our hypothesis tests, as the standard errors of the coefficients that are estimated in this manner provide consistent estimates of the true standard errors. Thus, asymptotically, tests of hypotheses using these estimates are not biased by ignoring heteroskedasticity. Estimating the standard errors for the estimated coefficients in model 1 in table 3.3 using White's heteroskedasticity-consistent covariance matrix shows no significant difference in t-ratios relative to the original OLS results.

Alternative Specifications of Promotion Variables

We now turn to a consideration of alternative specifications of promotion variables, as shown in equations 3.4a-d. The results from estimating these alternative models are shown in table 3.4. Equations 3.4a-d are denoted models 1-4 in table 3.4. Model 2 in table 3.4 is a special case of model 1 in that table, in which CPB and Sunsweet promotion are aggregated into a single promotion variable. This restriction is not rejected. Model 4 in table 3.4 is also a special case of model 1 (as well as model 3), and the implied restriction (that Sunsweet promotion has no effect on the market) is rejected conclusively. Models 1, 2 and 3 of table 3.4 are all acceptable models, but model 4 is not. These three models all say essentially the same things about the demand for prunes. The own-price elasticity of demand is inelastic, falling in a range of -0.3 to -0.5, the income elasticity of demand is about 1.2 to 1.6, the cross-price elasticity of demand with respect to the price of substitutes is about -1.4, and the elasticities of demand with respect to promotion are virtually identical among the three models. It should be noted that a negative cross-price elasticity could imply that the "substitute" good is, in fact, a complement. While it may be the case that dried fruit consumption moves in a complementary fashion with prune consumption, we suspect that the negative cross-price elasticity is capturing some of the downward trend in prune consumption that is not otherwise reflected in the trend variable. The elasticity of demand with respect to Prune Board promotion is estimated as between 0.048 and 0.052, while the elasticity of demand with respect to Sunsweet promotion ranges from 0.159 to 0.168. It is important to note that these elasticities refer to the effect of Prune Board and Sunsweet promotion on total sales of dried prunes. In particular the Sunsweet elasticity cannot be used to evaluate the effectiveness or profitability of Sunsweet promotion. To do so would require an elasticity of demand for *Sunsweet prunes* with respect to Sunsweet promotion. The elasticity estimates are all plausible (as discussed above in detail in relation to model 2 of table 3.4). The models explain a high proportion of the variation in prune consumption and appear to have generally acceptable statistical properties. For the models in table 3.4, model 4 failed one of the three RESET tests, indicating that omission of Sunsweet's promotion does result in a misspecified model.

Within-Sample Goodness of Fit: Models 1-3 in table 3.4 fit the data generally well, and the variables included explain about 81 percent of the variation in consumption of prunes. The close correspondence between actual per capita consumption and the estimated (fitted) values for model 2 in table 3.4 over the sample period is shown in figure 3.2a. The lower portion of the figure (3.2b) also includes a plot for model 2, showing the fraction of the fitted values accounted for by all of the variables other than promotion. In other words, it is the fitted values net of the estimated effects of promotion (calculated by subtracting $0.535 \times 10^{-2} \times (RPROCPB_t +$

Table 3.4: *OLS Estimates Comparing Different Specifications of Promotional Expenditures in the Preferred Monthly Model*

Independent Variables	(1)	(2)	(3)	(4)
Constant	0.019	0.015	0.019	0.083
	(0.330)	(0.283)	(0.340)	(1.367)
RPP	-0.291E-2	-0.305E-2	-0.229E-2	-0.153E-2
	(-0.740)	(-0.794)	(-0.579)	(-0.346)
	[-0.418]	[-0.437]	[-0.329]	[-0.220]
RPS	-0.904E-2	-0.910E-2	-0.953E-2	-0.817E-2
	(-2.180)	(-2.228)	(-2.324)	(-1.787)
	[-1.424]	[-1.433]	[-1.501]	[-1.287]
RPROCPB	0.305E-4	0.535E-2	0.280E-2	0.499E-2
	(2.25)	(6.339)	(2.498)	(4.824)
	[0.052]	[0.048]	[0.050]	[0.089]
RPROSUN	0.270E-4	0.535E-2	0.449E-2	
	(2.13)	(6.339)	(3.426)	
	[0.161]	[0.168]	[0.159]	
REXP	0.102E-5	0.129E-5	0.999E-6	-0.264E-5
	(0.34)	(0.505)	(0.343)	(-0.866)
	[1.248]	[1.585]	[1.230]	[-3.244]
WIN	0.182E-2	0.181E-2	0.183E-2	0.219E-2
	(3.76)	(3.797)	(3.823)	(4.176)
SPR	0.179E-2	0.173E-2	0.178E-2	0.301E-2
	(3.11)	(3.862)	(3.152)	(6.169)
SUM	-0.405E-3	-0.452E-3	-0.380E-3	0.220E-3
	(-0.83)	(-1.105)	(-0.791)	(0.438)
TIME	-0.826E-4	-0.911E-4	-0.820E-4	0.355E-4
	(-0.83)	(-1.047)	(-0.840)	(0.347)
Adjusted R^2	0.806	0.811	0.810	0.761
Log-likelihood	287.092	287.071	287.617	281.198
Durbin-Watson	2.118	2.114	2.124	2.078

Notes: t-statistics are in parentheses, elasticities (at means) are in brackets. Coefficient estimates on promotion variables (the b's) are calculated as $(b_{CPB}*RPROCPB+b_{SUN}*RPROSUN)^{1/2}$ in model 1; as $b*(RPROCPB+RPROSUN)^{1/2}$ in model 2; as $b_{CPB}*RPROCPB^{1/2}$ and $b_{SUN}*RPROSUN^{1/2}$ in model 3, and as $b_{CPB}*RPROCPB^{1/2}$ in model 4. Model 4, which does not use Sunsweet's promotional expenditures, failed one of the three Ramsey tests for misspecification.

$RPROSUN_t)^{0.5}$ from the fitted value in each month). The importance of promotion in the overall demand for prunes is clearly illustrated in figure 3.2b.

Autocorrelation: When the error term from one period is correlated with the error term in the next period, OLS standard errors are biased. A test for autocorrelation of the error terms was performed using the Durbin-Watson test for first-order autocorrelation. The Durbin-Watson statistics for models 1-3 in table 3.4 are around 2.1, suggesting an absence of first-order autocorrelation in the residuals.

Simultaneity and Endogeneity: If the price of prunes and promotional expenditures are statistically endogenous, then OLS is an incorrect procedure and we must use some other procedure (e.g., two-stage least squares) to account for the endogeneity. Endogeneity means that one or more of our independent variables is correlated with the error term, which violates an assumption in OLS. For instance, when promotion causes demand to increase, prune sales increase, which might plausibly lead to further expenditures on promotion. Such a feedback from consumption to promotion means that promotion expenditures are not exogenous. The important question is whether such feedback appears to be statistically significant in our model; in particular, feedback from consumption to either promotion or prices of prunes.

Prices and promotional expenditures are statistically exogenous, as we use the term, if we do not appear to bias the estimated coefficients by making the assumption that price and promotion are predetermined. In order to evaluate this question, Hausman tests for exogeneity were applied. We performed three tests. First we tested whether prices alone were exogenous, second, whether promotion alone was exogenous, and finally, whether prices and promotion together may be treated as exogenous. The test compares two different sets of estimates of the coefficients. Under the null hypothesis of exogeneity, OLS is appropriate. Under the alternative hypothesis, price and promotion are endogenous, and a different estimation technique, instrumental variables or two-stage least squares, must be used. The Hausman test involves a comparison of the two sets of estimates. If the estimates differ significantly, this is taken as evidence against the null hypothesis of exogeneity.

To perform the Hausman test, then, we re-estimated the model using an auxiliary regression procedure (see Davidson and Mackinnon 1993). We did so for each case (price endogenous, promotion endogenous, and both endogenous) for the models in table 3.4.[10] In every model, we rejected the hypothesis that both price and promotion are exogenous. Specifically, we found that price and CPB's promotion were endogenous in models 1 and 3, price and the aggregate promotion variable $(RPROCPB+RPROSUN)^{1/2}$ were endogenous in model 2, and CPB's promotion alone was endogenous in model 4. Given these results, our next

[10] For tests on promotion, we tested whether only CPB's promotion was endogenous, whether only

step was to re-estimate each of the four models presented in table 3.4 using a two-stage least squares (2SLS) procedure that treats both price and promotion as endogenous.

Results from Models Estimated by Two-Stage Least Squares (2SLS)

The results from estimating models 1-4 using 2SLS are reported in table 3.5. Since the only difference between the four models in table 3.4 and those in table 3.5 is the method of estimation (each model includes the same variables), the OLS and 2SLS results are easily compared. While the results in the two tables are broadly similar, close examination of the estimated coefficients and their associated elasticities reveals important differences resulting from estimation method. First, there is much more variation in the estimated price and income elasticities among the four models estimated using 2SLS methods in table 3.5 than among the same four models estimated by OLS in table 3.4. Second, there are significant differences between the estimated coefficients for the same models estimated by different methods. Following is a brief comparison that highlights the results.

Among the 2SLS models in table 3.5, model 4 was rejected as implausible, since it led to a positive own-price elasticity of demand. Proper specification requires that Sunsweet promotion be included as an explanatory variable. Model 2, when estimated by 2SLS, was also rejected because the hypothesis that the effects of generic and brand advertising were equal, as reflected by the restriction of equal effects between the two types of promotion, was not supported. The remaining two models in table 3.5 (1 and 3) imply essentially the same things. In both models, the coefficient on income is negative (it was positive in the three acceptable OLS models) but statistically insignificant. The calculated income elasticities are very large and negative (-6.7 to -7.5), values that would be difficult to justify if they were statistically significant. While it is plausible that prune demand falls with increased income, these elasticities seem implausibly large. The own-price elasticity of demand is substantially smaller (-0.1 to -0.2) than in the OLS models, but the estimated price coefficients are not statistically significant in either set of models. Importantly, the elasticity of demand with respect to CPB promotion is much larger in the 2SLS models (0.13 to 0.15) than in the OLS models (about 0.05), while the elasticity of demand with respect to Sunsweet promotion is smaller and no longer statistically significant in the 2SLS models.

A Summary of Monthly Demand Estimates

In summary, the four-step procedure used to estimate the monthly demand models for dried prunes resulted in several alternatives being considered. In the first step, a screening procedure was used to select the independent variables to be included in the estimated model.

Sunsweet's promotion was endogenous, and whether both were jointly endogenous.

Table 3.5: *2SLS Estimates Comparing Different Specifications of Promotional Expenditures in the Preferred Monthly Model*

Independent Variables	(1)	(2)	(3)	(4)
Constant	0.142	0.065	0.133	0.145
	(1.76)	(1.078)	(1.561)	(1.958)
RPP	-0.847E-3	-0.817E-2	-0.136E-2	0.371E-2
	(-0.11)	(-1.515)	(-0.170)	(0.673)
	[-0.121]	[-1.172]	[-0.195]	[0.531]
RPS	-0.907E-2	-0.999E-2	-0.950E-2	-0.927E-2
	(-1.81)	(-2.257)	(-1.954)	(-1.732)
	[-1.429]	[-1.573]	[-1.496]	[-1.460]
RPROCPB	0.768E-4	0.699E-2	0.725E-2	0.901E-2
	(2.33)	(5.272)	(2.114)	(4.744)
	[0.152]	[0.063]	[0.129]	[0.161]
RPROSUN	0.488E-5	0.699E-2	0.140E-2	
	(0.43)	(5.272)	(0.551)	
	[0.034]	[0.220]	[0.050]	
REXP	-0.608E-5	0.910E-6	-0.546E-5	-0.674E-5
	(-1.39)	(-0.315)	(-1.132)	(-1.749)
	[-7.482]	[-1.119]	[-6.711]	[-8.289]
WIN	0.172E-2	0.152E-2	0.174E-2	0.173E-2
	(2.89)	(2.811)	(3.037)	(2.742)
SPR	0.303E-2	0.142E-2	0.286E-2	0.336E-2
	(3.59)	(2.803)	(2.819)	(5.764)
SUM	0.773E-3	-0.302E-3	0.651E-3	0.103E-2
	(0.97)	(-0.678)	(0.726)	(1.575)
TIME	0.142E-3	-0.144E-4	0.124E-3	0.157E-3
	(1.00)	(-0.145)	(0.803)	(1.233)
Durbin-Watson	2.101	2.128	2.116	2.112

Notes: t-statistics are in parentheses, elasticities (at means) are in brackets. Coefficient estimates on promotion variables (the b's) are calculated as $(b_{CPB}*RPROCPB+b_{SUN}*RPROSUN)^{1/2}$ in model 1; as $b*(RPROCPB+RPROSUN)^{1/2}$ in model 2; as $b_{CPB}*RPROCPB^{1/2}$ and $b_{SUN}*RPROSUN^{1/2}$ in model 3, and as $b_{CPB}*RPROCPB^{1/2}$ in model 4. The added instrumental variables used in the 2SLS estimation were a squared trend variable, the real price of raisins, and the real price of all other dried fruit. Endogenous, right-hand-side variables in the 2SLS models were chosen based on Hausman tests. These endogenous variables are *RPROCPB+RPROSUN* and *RPP* in model 2; *RPP* and *RPROCPB* in models 1 and 3, and *RPROCPB* alone in model 4.

The preferred model included variables for the retail price of prunes, the retail price of other dried fruit, CPB and Sunsweet promotion, and per capita income, all in real terms, as well as seasonality (quarters) and a time trend. The variables included in this model explained a high proportion of the variation in prune consumption, and most of the estimated coefficients, while not always significant, were consistent with expectations.

The second step was to subject the estimated models to a set of diagnostic tests. These tests indicated that three of the four models were properly specified with regard to functional form and the variables included. In the fourth model, omitting the effect of Sunsweet promotion did result in a specification error. While model 1 in table 3.3 had some evidence of heteroskedasticity, it was a problem that could be ignored without biasing the results. No corrections for heteroskedasticity were required.

The third step in the monthly estimation procedure was to retain the variables included in the preferred model and investigate four alternative specifications of the promotion variables. Three of the four models estimated using OLS procedures resulted in statistically acceptable results that were quite stable from model to model. The fourth model, which excluded Sunsweet promotion, was found to be misspecified. Regardless of the square-root form used, CPB and Sunsweet promotion expenditures always had statistically significant positive effects on prune demand. The estimated elasticities for CPB promotion expenditures ranged from 0.048 to 0.052, while the elasticities for Sunsweet promotion expenditures ranged from 0.159 to 0.168.

Application of the Hausman test resulted in rejection of the null hypothesis that price and promotion were exogenous variables in the OLS estimates in table 3.4, and acceptance of the alternative hypothesis that they were, instead, endogenous. The fourth and final step was to re-estimate each of the OLS models presented in table 3.4 using 2SLS procedures. The 2SLS results, while preferred from a statistical standpoint, do raise some questions. The coefficients and elasticities are much more variable among models than those estimated by OLS. The price elasticities estimated by 2SLS were much smaller than those estimated by OLS, and the 2SLS income elasticities became very negative while the coefficients on time became positive. The elasticity of demand with respect to CPB promotion increased in the 2SLS estimates, while Sunsweet promotion elasticities decreased and became statistically insignificant. While we are unsure of the exact “causes” of these changes, the nature of the data certainly played a role. Because of the relatively short period covered by the data, there was little variation in observed prices or income. There is also correlation between income and time, and we were unable to identify a statistical substitute for dried prunes. Hence, even though the statistical tests support the use of 2SLS, the OLS models are more satisfactory in terms of the consistency of the parameter estimates with prior beliefs about plausible or likely values. And, the fact that the OLS models imply smaller elasticities of demand response to CPB expenditure means that, in one sense, the OLS estimates are more conservative. Importantly, across all specifications, the effect of CPB promotion was statistically significant, and the coefficients were very similar among the models.

3.3 Aggregate Annual Demand Models, 1949-1995

Annual data were available for the period 1949 through 1995, as documented in section 2 of this report. The essential theory for an annual model of demand is identical to that for the monthly model. The primary differences are that, with an annual model, seasonality is absent, and the longer time period of analysis may allow some more useful variation in relative prices and incomes to have occurred, as well as the potential for explicitly accounting for the dynamic effects of changing demographic variables, such as the age distribution of the population. On the other hand, the longer time period needed to estimate an annual model also means that it is less likely that the parameters of any estimated model will remain stable over time, without structural change.

Models

As with the monthly demand model, decisions must be made about the functional form for demand and the variables to be included. The equation for the annual model is:

$$\begin{aligned} Q_t = \beta_0 + \beta_{PP} RPP_t + \beta_{PS} RPS_t + \beta_{INC} RINC_t + \beta_{PRO}\sqrt{RPROMO_t} \\ + \beta_{AGE} AGE65_t + \beta_T TIME + \beta_{LAG} Q_{t-1} + e_t \end{aligned} \tag{3.5}$$

This annual demand model (equation 3.5) includes many of the same variables as the monthly demand model (equation 3.4). The differences from the monthly model relate to the dynamic specification, in terms of the role of the fraction of people over 65 years old, the aggregation of Sunsweet and CPB promotion, and the inclusion of the lagged dependent variable. [11] The age and trend variables were discussed earlier. The lagged dependent variable often is interpreted as reflecting partial adjustment of desired quantities consumed from year to year, or habit persistence. However, it can also be included to detect the possibility of an incorrect specification, rather than true dynamic effects on consumption.

[11] Annual Sunsweet promotion data were not available for the years 1949 to 1968.

Table 3.6: *Description of Variables in the Annual Demand Model*

Variable	Definition	Units	Data Source
$TIME_t$	Year	years	
Q_t	Quantity of dried California prunes shipped in the United States per million people from August 1 of year t to July 31 of year t+1	pounds of dried prunes per person per year	Prune shipments from California Prune Board. U.S. population from U.S. Statistical Abstract
RPP_t	Real average price of prunes received by growers, in year-of-harvest	real (1995=1.00) dollars per pound of prunes in processed condition	Agricultural Statistics, USDA
RPR_t	Real average price of raisins received by growers in year-of-harvest	real dollars per pound of raisins	Agricultural Statistics, USDA
$RINC_t$	Real average U.S. per capita income in the calendar year after the year-of-harvest	real dollars per person per year	U.S. Statistical Abstract, U.S. Dept. of Commerce
$AGE65_t$	Percentage of U.S. population 65 years old or older in the calendar year after the year-of-harvest	fraction between 0 and 1	U.S. Statistical Abstract, U.S. Dept. of Commerce
$RPROMO_t$	Real expenditures by the California Prune Board and Sunsweet Growers on all types of domestic promotion (includes advertising, promotion, and public relations), from August 1 of year t to July 31 of year t+1	millions of real dollars per year	California Prune Board and Sunsweet Growers.

Table 3.7: *Summary Statistics of the Variables in the Annual Demand Model*

Variable	N	Mean	Standard Deviation	Minimum	Maximum
Q	47	0.601	0.224	0.372	1.153
RPP	47	0.639	0.152	0.396	1.026
RPR	47	0.666	0.250	0.433	1.296
RINC	47	17.293	4.800	9.622	24.385
AGE65	47	0.105	0.015	0.081	0.130
RPROMO	47	3.821	2.541	0.0	8.776
TIME	47	1972	13.711	1949	1995

Data

The variables used in the annual demand model are defined in table 3.6. Several of these variables were graphed in section 2 of the report, and the trends were discussed there. Summary statistics for these variables are shown in table 3.7. Data can be found in appendix table A3.2.

Some issues arose from the fact that the annual observation periods differed among the key economic variables. This meant that some lead-lag relationships among the observed variables could arise, even though the underlying data generating process was one in which contemporaneous observations of the independent variables were relevant for the determination of consumption. This issue is not important for the income and the age variables, which simply do not vary significantly from one year to the next. The only real decision was whether to use the price from the fall period at the beginning of the current year, in conjunction with the quantity and expenditure on promotion from the same period through to the end of that twelve-month period. To the extent that this price is not an accurate representation of the relevant annual prices, bias is introduced into the model.

Estimation Results and Selection of the Preferred Annual Model

The annual demand model presented in equation 3.5 was estimated using the annual data described above. As with the monthly model, the statistical effects of deleting various variables were investigated as indicators of the robustness of certain aspects of the model. The estimation results for models estimated by OLS are shown in table 3.8. Variants of the model shown in column (1) of the table were derived by restricting selected parameters in the most general form to zero (in other words, by dropping certain potential explanatory variables). For each equation, the variables appearing in the model are those for which estimated coefficients are reported. Note that the results in table 3.8 were obtained using the square-root of total promotion.[12]

All of the models estimated had relatively high adjusted R^2 values—the model with the lowest value still explained over three-fourths of the variation in per capita prune consumption. High R^2 values, however, are quite common with time-series data. Perhaps the most striking aspect of these models is that few of the coefficients are statistically significant. In particular, the coefficient on promotion was not statistically significant in any of the annual models. We checked whether this was also true of the model with real promotion *(RPROMO)* in levels, rather than square-root form, and found that *RPROMO* was statistically significant only if

[12] Several other models and alternative estimation techniques were investigated. Corrections for autocorrelation provided results that were similar to those in table 3.8, as did models in which promotion entered linearly, rather than in the square-root form.

AGE65 and *QSLAG* were left out of the model. Apparently, *AGE65* and the lagged dependent variable explain so much of the variation in prune consumption that we cannot separate out an effect of promotion. Only the coefficients on the price of prunes, *RPP*, and last year's domestic shipments, *QSLAG*, have consistently significant t-statistics, while the *AGE65* variable appears to be significant when *QSLAG* is deleted. Note also that the (one-year) own-price elasticity of demand for prunes is quite small, around -0.3 in all models. However, the long-run elasticity, calculated by taking the price coefficient and dividing by one minus the coefficient on the lagged dependent variable, is roughly -1.

When the lagged dependent variable is not included, the Durbin-Watson statistic shows evidence of significant autocorrelation. Even when *QSLAG* is included in the model, there appear to be significant problems with unexplained dynamic effects. Promotion still does not have any statistically significant effect on demand, over the longer period covered by this annual model, when such dynamic effects are accounted for.

After examination of the results, the model closest to being a "preferred" model in table 3.8 is the one originally specified in equation 3.5, which appears in column (1). However, this model shows no statistically significant effects of promotion.

This result might be more worrisome if we were more confident about the annual models. However, application of the diagnostic tests that were described in detail in section 3.2 confirmed that the annual models could not be used with much conviction. We used the *DIAGNOSTIC* procedure in *SHAZAM* to perform several tests on model (1) in table 3.8. We also performed the tests on models where *RPROMO* enters linearly. All three of the variants of Ramsey's specification error test *(RESET)* led us to reject the hypothesis of no misspecification in all of the models shown in table 3.8. Not passing the model specification test means that other tests cannot be relied upon. As can be seen in the tables, dynamic effects must be accounted for, as an autocorrelation correction appears to be called for in the model where the lagged dependent variable is not included.

Table 3.8: *Coefficient and Elasticity Estimates from Annual Prune Demand Models*

Independent Variables	(1)	(2)	(3)	(4)
Constant	30.555 (1.754)	21.621 (1.414)	116.740 (4.284)	5.714 (0.766)
RPP	-0.257 (-4.221) [-0.279]	-0.363 (-2.887) [-0.385]	-0.305 (-2.810) [-0.324]	-0.265 (-4.294) [-0.288]
RPR	0.005 (0.111) [0.005]	-0.129 (-1.481) [-0.143]	-0.112 (-1.501) [-0.124]	0.011 (0.244) [0.012]
RINC	0.007 (0.547) [0.196]	-0.010 (-0.454) [-0.292]	0.029 (1.363) [0.845]	-0.003 (-0.234) [-0.075]
$RPROMO^{1/2}$	0.007 (0.423) [0.014]	-0.017 (-0.533) [-0.034]	-0.001 (-0.010) [-0.002]	0.004 (0.232) [0.008]
TIME	-0.016 (-1.729)	-0.010 (-1.308)	-0.061 (-4.229)	-0.003 (-0.708)
AGE 65	8.346 (1.572)		33.476 (3.981)	
QSLAG	0.721 (9.386) [0.740]			0.780 (11.440) [0.801]
Adj R^2	0.945	0.779	0.838	0.943
Durbin-Watson	na	0.383	0.521	na
Sample	1948-1995	1949-1995	1949-1995	1948-1995

Notes: t-statistics are in parentheses, elasticities (at means) are in brackets. Elasticity in the row $RPROMO^{1/2}$ is the elasticity of demand with respect to promotional expenditure, not its square root. na = not applicable.

4. SIMULATION MODEL AND BENEFIT-COST ANALYSIS

In this section, the estimated monthly demand parameters from the previous sections are used to estimate the gross and net benefits to the California prune industry from its expenditures on promotion. Both the OLS and 2SLS models of monthly retail demand are used to show a range of estimated values for gross and net benefits. The analysis includes the misspecified models that omit brand promotion, to provide a measure of the difference in estimated benefits that would result from excluding, or not acquiring data on, a relevant variable.

4.1 Approaches for Evaluating the Benefits from Promotion

Measuring the welfare impacts of promotion funded by check-offs requires (a) a conceptual structural model of the industry market equilibrium, (b) estimates of supply and demand parameters that can be used to define the values for the parameters in the structural model, (c) estimates of the demand response to promotion expenditures, and (d) information to allow a transformation of the effects of promotion (through retail demand shifts) and assessments or check-offs (through commodity supply shifts) into measures of benefits and costs.

Conceptual Model of Supply and Demand

The econometric work discussed in the previous section allows us to estimate how much the quantities sold of prunes would increase in response to a given increase in promotional expenditures, holding prices (and other variables) constant. This does not, however, tell us how much sales will actually increase when promotion changes, since prices cannot be assumed to remain constant. Indeed, the increase in prices following a promotion-induced shift in demand is an important source of the benefits realized by growers and packers of prunes. In order to properly evaluate the industry's demand-shifting activities, therefore, we must account for both demand effects and the response of supply to increased price.

Demand Shifts from Promotion: The diagram in figure 4.1 illustrates the conceptual supply and demand relationships for a typical year *t*. In the figure, the line labeled S_t represents the supply curve for prunes. It shows the quantities available to domestic consumers at various prices; at higher prices, more fresh prunes are available domestically, while at lower prices, larger quantities of prunes are diverted to other uses, such as to the export market, or they may be left unharvested. The line labeled $D_t(RPROCPB_t)$ represents the demand curve: at higher prices, consumers purchase a smaller quantity of prunes than at lower prices, holding other factors constant. In particular, the promotional expenditure by the CPB is held constant at its actual value, $RPROCPB_t$, along this demand curve.[13] The equilibrium price, at which quantities supplied and demanded are the same, is the price observed at point E: price P_t is consistent with the observed quantity Q_t.

In this example, the effects of a ten percent increase in CPB promotion, $RPROCPB_t$, are illustrated by the outward shift in the demand curve. The new curve is labeled $D_t(RPROCPB_t \bullet 1.1)$. The econometric model allows us to estimate the horizontal distance of the demand shift, identified by Δ in the diagram. In the OLS model given in equation 3.4b, for example (column 1 of table 3.3 or column 2 of table 3.4), the coefficient on $(RPROCPB_t)^{1/2}$ is 0.535×10^{-2}. Suppose the actual monthly promotion expenditure is $1 million (in 1996 dollars). This means that a $0.1 million (i.e., ten percent) increase in total promotional expenditures would be expected to lead to an increase in per-capita prune consumption of $0.535 \times 10^{-2}(1.10^{.5} - 1.00^{.5}) = 0.26 \times 10^{-3}$ pounds per month, if there is no change in price.

Multiplying by the population (POP_t = 265.5 million in 1996) yields the total horizontal demand shift from a ten-percent increase in promotional expenditures, about a 2.1 percent increase in consumption, at constant prices. However, this is greater than the actual increase in consumption that would result. An increase in price is needed to bring forth the additional quantities to satisfy the increased demand. This is reflected in the fact that the supply curve slopes up. The new equilibrium is given by the point where the new demand curve crosses the supply curve, E'. Price and quantity both increase to the new equilibrium values P_t' and Q_t'.

Producer Benefits: The evaluation of promotional expenditures requires both an estimate of the increments in prices and quantities due to the expenditures, and a measure of the costs of supplying the additional quantities to the market. In the diagram, increased prices call forth additional supplies; these supplies come at a cost, which, in the case of a perennial crop, may largely be the earnings foregone from other uses of existing production (e.g., exports), rather than new production. The sellers who were already in the market at price P_t profit by the increase in price to P_t'; their gain is $(P_t' - P_t)Q_t$, or the area $P_t'aEP_t$ in the diagram. The gains to the sellers of additional supplies are much smaller, as they must be reduced by the cost (including revenues from foregone sales in other markets) of the additional quantities. This benefit is given by the area of the triangle aEE' in the diagram. The total gain to prune producers is given by the area of the trapezoid $P_t'E'EP_t$; this represents the gain in *producer surplus* resulting from the ten percent increase in promotional expenditures. Changes in producer surplus coincide with changes in producers' economic profit, from the production of

[13] The econometric work discussed in the previous section provides estimates of the shape and position of this line. In particular, the inverse of the price coefficient is the line's slope (the price coefficient tells the change in quantity demanded in response to a unit increase in price), while the horizontal position of the curve is given by the sum of the products of the values of each of the other variables, in year or month t, times their corresponding coefficients.

prunes, in such a situation. The only information required, in addition to the econometrically estimated demand parameters for responses to prices and promotion, is information on the supply response to price.

Costs of Assessments to Finance Promotion: The gain in producer surplus is not adjusted for the cost of the increase in promotional expenditures. To evaluate the profitability of these expenditures, the gain must be set against the cost. We use two measures of cost. One measure is the total cost of the marginal increase in expenditure. However, when the promotional cost is financed by a per-pound assessment, some of the incidence of the assessment falls on consumers, as a result of increased retail prices. Thus, the total cost may differ from the cost to producers. A second measure compares the benefits to producers with the producers' share of the cost, allowing that some of the costs of the assessment are borne by consumers.

Figure 4.2 shows the same initial supply and demand curves as in the above figure, labeled $S_t(\tau_t)$ and D_t, where τ_t represents the actual assessment per pound in year t, and the equilibrium is at point E, with price P_t and quantity Q_t. An increase in the assessment per pound is reflected as a shift up of the supply curve to $S_t(\tau_t')$ by the amount of the increase (given by simply adding the additional assessment to the previous price at which producers would be willing to supply any given quantity along the supply curve). This leads to a new equilibrium, at point E', with a higher consumer price P_t', a smaller net producer price ($b = P_t' - \tau_t'$), and a smaller quantity produced and consumed, Q_t'.

The extent of the consumer price increase depends on the slopes of the supply and demand curves. If supply were fixed and unresponsive to price (so that the supply curve is a vertical line), there would be no increase in the consumer price and all of the additional assessment would be borne by producers. The more price-responsive (the flatter, or more price elastic) is supply, the smaller will be the proportion of the assessment borne by producers.

The additional amount of assessment revenue is equal to $\tau_t'Q_t' - \tau_tQ_t$. For small changes in the assessment, this is approximately equal to the change in the assessment times the final quantity: $(\tau_t'-\tau_t)Q_t'$. In figure 4.2, this is equal to area $P_t'E'ab$. This area corresponds closely to the full social cost of the change in assessment to finance a change in promotional expenditure of that amount (it leaves out the area of the triangle $E'Ea$, which is negligible for the small changes in assessments to be considered here). The loss of producer surplus (or profit) associated with the same increase in the assessment is equal to area P_tEab, only a fraction of the total amount being spent. In the work below, we compare producer benefits and the two alternative measures of producer costs.

4.2 An Approximation Using Elasticities

Before turning to the specification of the supply side and the simulation models for computing benefit-cost ratios, we report results from an approximation procedure, using just the estimated elasticities of demand with respect to price and promotion, and the promotion intensity (promotion expenditure per dollar of sales).

As discussed by Alston et al. (1997), much of the literature on optimal primary product promotion rests on two foundational papers on the economics of advertising: Dorfman and Steiner (1954) and Nerlove and Waugh (1961). According to the Dorfman-Steiner theorem, given fixed output, a monopolist will maximize profits by setting the advertising budget such that the increase in gross revenue resulting from a one dollar increase in advertising expenditure is equal to the own-price elasticity of demand for the product. That is,

$$\frac{\partial v}{\partial a} = \eta \text{ or } \frac{a}{v} = \frac{\alpha}{\eta} \quad \text{where } \alpha = \frac{\partial v}{\partial a}\frac{a}{v} \quad .$$

In this equation, a is the advertising expenditure, v is the value of sales (the product of price, p and the quantity sold, q), α is the elasticity of demand with respect to advertising, and η is the absolute value of the elasticity of demand with respect to the price.

The Dorfman-Steiner result may be applicable to a number of primary products where output is fixed (e.g., by a quota) and a marketing organization advertises on behalf of producers. However, the more relevant reference for a study of promotion by a producer group without the ability to control output is that by Nerlove and Waugh (1961). Like Dorfman and Steiner (1954), Nerlove and Waugh (1961) modeled a case where advertising is funded in a lump-sum way, unrelated to output, with the implication that all of the advertising cost is borne by producers. That approach has been adopted in many subsequent studies of primary product promotion. Alston, Carman, and Chalfant (1994) extended the Nerlove-Waugh model to the situation where advertising is funded by a per unit check-off. The condition for optimal advertising that they derived is the same as the Dorfman-Steiner condition for optimal advertising by a monopolist with fixed output.[14]

The same logic leads to the result that μ, the benefit from a marginal increase in promotion expenditure (for an increase in promotion financed by a check-off), can be approximated using

[14] It is different from the Nerlove-Waugh condition for optimal advertising financed in a lump-sum fashion (but equivalent if the producers' share of the lump sum is equivalent to their share of a check-off).

Table 4.1: *Approximation of μ, the Benefit from a Marginal Increase in Promotion Expenditure*

Models	Mean	Minimum	Maximum
	Based on OLS Models		
1	3.29	2.51	4.62
2	2.90	2.23	4.06
3	2.42	1.86	3.15
4	6.45	4.96	8.39
	Based on 2SLS Models		
1	36.44	20.41	72.81
2	1.42	1.09	1.98
3	10.55	8.11	13.71
4	4.82	3.70	6.26

Notes: The regression estimates for the models above are given in tables 3.4 and 3.5.

$$\mu = Q \frac{\partial P}{\partial a} = Q \frac{\partial Q}{\partial a} \left| \frac{\partial P}{\partial Q} \right| = \frac{\alpha}{|\eta|} \frac{v}{a} = \frac{\alpha}{|\eta|\iota}$$

where $\iota = a/v$ is the intensity of promotion (or advertising). This result is intuitively clear, in the case where supply is fixed and the producer benefits from advertising are exactly equal to the price increase induced by the demand shift, multiplied by the quantity supplied. It also applies more generally when advertising is financed by a check-off.

Using the results from the preferred monthly regression models, we computed values for μ at every monthly data point. These results are given in table 4.1. In all of the instances examined, the estimated benefit from a marginal increase in the promotion expenditure exceeds 1.0.

4.3 Simulation Model

The simulation model combines results from the monthly demand analysis with assumed supply parameters. We compare the pattern of consumption and prices predicted by the estimated model, given the actual historical promotion activities, with the corresponding values predicted by the model following a counterfactual one percent increase in promotional expenditure in every month in the sample (September 1992 to July 1996). We also simulate changes in the assessments jointly with the corresponding changes in promotion. We use the differences between these actual and counterfactual scenarios to calculate measures of the *marginal* gross and net benefits.

Since changes in more than one month are to be simulated, it is necessary to be able to aggregate benefits and costs over time. A natural impulse may be simply to add them up. This is appropriate only if past benefits or costs could not have been invested to earn some interest. If the relevant interest rate is not zero, past benefits and costs should be compounded forward to the present. We computed present values of benefits and costs using an annual interest (compounding) rate of three percent (a reasonable value for the long-term, risk free, *real* rate of interest).

The Supply Model

To conduct the benefit-cost analysis, the preferred demand model is combined with an assumed supply function. First, from the demand side, the *predicted quantities* were calculated by substituting the actual values for each of the explanatory variables into the estimated equation. For instance, for model 3.4b (columns 2 in tables 3.4 and 3.5),

$$\hat{Q}_t = \hat{b}_0 + \hat{b}_{PP}\, RPP_t + \hat{b}_{PR}\, RPS_t + \hat{b}_{EXP}\, REXP_t + \hat{b}_{PRO} \sqrt{RPROCPB_t + RPROSUN_t} + \hat{b}_{SPR} SPR_t + \hat{b}_{WIN} WIN_t + \hat{b}_{SUM} SUM_t + \hat{b}_T TIME_t \tag{4.1}$$

where the hats (^) on parameters denote their estimated values, and the hat on Q_t denotes the predicted value given the estimated coefficients and the values of the exogenous variables. We replicated this step for each of the four models, estimated by both OLS and 2SLS.

Next, the supply function was defined to be of the constant elasticity form and to pass through the points defined by the predicted quantities from the demand model. That is, the supply function is of the form

$$Q_t = A_t R_t^{\varepsilon} \text{ where } A_t \equiv \hat{Q}_t / R_t^{\varepsilon}, \tag{4.2}$$

and R_t is the producer return per pound in year t, defined as $R_t = (1\text{-}\tau_t)P_t$, where τ_t is the actual promotional expenditure per pound consumed in year t, expressed as a fraction of the market price in year t (i.e., the rate of assessment required to finance the actual promotional expenditure). A_t is a parameter that varies from month to month to ensure that, given the actual values of prices and the other exogenous variables, each month the supply equation passes through the point defined by the predicted quantity from the demand model and the actual price. This means that we can combine the calibrated supply model and the estimated demand model to simulate the past actual prices and predicted quantities.

Supply functions were calibrated using alternative supply elasticities (ε) of 0, 0.5, 1.0, 2.0, and 5.0. This range of elasticities reflects a range of lengths of run; it also reflects our uncertainty about the exact implications of international trade in prunes for the elasticity of the *residual* supply to the domestic market.

Changes in producer surplus were calculated by integrating the function over the range of a price change. In practice, this translates to using the following formula for the change in producer surplus:

$$\Delta PS_t = \frac{R_t' Q_t' - R_t Q_t}{1 + \varepsilon} \tag{4.3}$$

Simulations

Using these definitions of supply and demand equations, we first replicated the past: by equating the equations for supply and demand and solving for market equilibrium, we obtained values of actual prices and predicted quantities (from the demand model), given the actual values for the exogenous variables. In addition, we simulated counterfactual scenarios, by using hypothetical values for the exogenous variables.

Counterfactual simulations were conducted by:

- using hypothetical values for the CPB's promotional expenditure in every year (1.01 times the actual values) with actual assessment rates (in practice we define "actual" assessment rates by expressing total promotional expenditure as a fraction of the total value of production)
- using hypothetical values for the assessment rate in every year (1.01 times the actual values) with actual promotional expenditure
- changing both the promotional expenditures and the assessments (setting both at 1.01 times the actual values)

For each simulation, we calculated two measures of producer marginal costs of promotion: (a) the cost of the marginal promotional expenditure, and (b) the producer surplus loss associated with an assessment sufficient to generate the same amount of additional expenditure. Only selected summary results are reported below.

An important issue is to know how much confidence can be placed in the particular values of the benefit-cost measures. How confident can we be that the net benefits are greater than, say, $1 million, given a "best" estimate of, say, $2 million? The precision of our estimates of the benefits depends on the precision of our estimates of the underlying parameters, but in ways that are not easy to see clearly. To evaluate the precision of our measures of benefits and costs, we conducted Monte Carlo simulations, following the approach laid out in Alston et al. (1997). These simulations yield confidence intervals on our welfare measures, permitting us to make statements such as that a 95% confidence interval for the benefit-cost ratio is formed by the interval from a:1 to b:1, where a is a lower confidence limit and b is an upper confidence limit.

In practice, to do this requires an iterative process where first a particular set of values of the parameters is drawn at random from the estimated joint statistical distribution. This set of parameters is substituted into the demand equation and used to generate predicted quantities which are, in turn, used to parameterize the supply equation for each supply elasticity. Then these supply equations are used with the demand equation to conduct the counterfactual scenarios, and then to evaluate the scenarios. The detailed results from the Monte Carlo study are reported in appendix tables A4.1-A4.3.

Benefit-Cost Ratios

Table 4.2 reports marginal benefits and costs of prune promotion implied by each of the four demand models estimated by both OLS and 2SLS, using five alternative values for the

Table 4.2: *Marginal Benefit-Cost Ratios for Prune Promotion: A Comparison of Estimates from Four Regressions using both OLS and 2SLS*

	Supply Elasticity				
Series	0.0	0.5	1.0	2.0	5.0
	Benefit-Cost Ratios from OLS Models				
Model 1					
Producer Benefits/Producer Costs	3.00	2.99	2.99	2.99	2.99
Producer Benefits/Total Expenses	3.00	1.32	0.85	0.50	0.22
Model 2					
Producer Benefits/Producer Costs	2.65	2.65	2.65	2.65	2.65
Producer Benefits/Total Expenses	2.65	1.20	0.78	0.46	0.20
Model 3					
Producer Benefits/Producer Costs	3.82	3.85	3.86	3.86	3.87
Producer Benefits/Total Expenses	3.82	1.48	0.92	0.52	0.23
Model 4					
Producer Benefits/Producer Costs	10.19	10.29	10.30	10.31	10.32
Producer Benefits/Total Expenses	10.19	3.02	1.78	0.97	0.41
	Benefit-Cost Ratios from 2SLS Models				
Model 1					
Producer Benefits/Producer Costs	29.32	29.61	29.63	29.64	29.65
Producer Benefits/Total Expenses	29.32	5.49	3.03	1.60	0.66
Model 2					
Producer Benefits/Producer Costs	0.86	0.86	0.86	0.86	0.86
Producer Benefits/Total Expenses	0.86	0.61	0.48	0.33	0.17
Model 3					
Producer Benefits/Producer Costs	16.80	17.02	17.05	17.07	17.08
Producer Benefits/Total Expenses	16.80	4.56	2.64	1.43	0.61
Model 4					
Producer Benefits/Producer Costs	5.82	5.86	5.88	5.89	5.91
Producer Benefits/Total Expenses	5.82	3.43	2.44	1.54	0.74

Notes: Present Values are in millions of constant (August 1996) dollars using 3 percent (annual) compounding.

supply elasticity. A real discount rate of 3 percent per annum was used to compound the costs and benefits. In each case, we report both producer benefits relative to *producer costs* associated with a change in assessment to finance a change in promotion, along with the producer benefits relative to the *total costs* of the change in promotional expenditure (not just the producer share). For example, the first row in table 4.2 refers to model 1 estimated by OLS and the first column represents a supply elasticity of zero. Thus, using a supply elasticity of zero and a demand model based on OLS estimation of model 1, the benefit-cost ratio for a one percent increase in promotional expenditure is 3.00, regardless of whether we distinguish between producer cost and total cost (they are the same when the supply elasticity is zero). Looking across the columns in this row, we can see the effects of the increase in the supply elasticity. We can see that the supply elasticity does not affect the benefit-cost ratio when we consider only the producer share of the cost of the checkoff — the benefit-cost ratio is essentially 3.00 regardless of the value of the supply elasticity. However, as the supply elasticity rises, producers receive progressively smaller benefits from a given demand increase. Hence, the benefit-cost ratio computed using total promotional expenditure declines with increases in the supply elasticity, going from 3.00 when supply is fixed, to 0.22 when the supply elasticity is 5.0. This pattern is repeated across all the models (and, looking across the rows and comparing within a column, we can see the effects of the different demand models). Thus, a primary issue is whether incremental promotion is financed by incremental changes in assessments or in a lump-sum fashion (see Goddard et al. (1994), Alston, Carman, and Chalfant (1994), and Alston et al. (1997)). In what follows, we emphasize the results obtained by comparing producer benefits to producer costs, rather than to total expenses, where total expenses are partly borne by producers and partly by consumers, to the extent that costs of the assessment are passed on through higher consumer prices.

Table 4.3 reports the point estimates for the ratio of producer benefits to producer costs from table 4.2, calculated using a supply elasticity of 1.0 (but representative of all supply elasticities), with the corresponding results from the Monte Carlo simulation. We report the mean and the upper and lower limits from a 95 percent confidence interval. Recall that, in the OLS models, model 4, which did not include Sunsweet promotion, was rejected, but models 1, 2, and 3 were not. Comparing the point estimates for these three models, the estimated benefit-cost ratios fall within a relatively narrow range from 2.65 to 3.85. An analyst who had inadvertently omitted Sunsweet promotion from the analysis (model 4) would have estimated a benefit-cost ratio of 10.3 –– a clear example of omitted-variable bias leading to a biased benefit-cost ratio.

While the OLS benefit-cost estimates for models 1, 2, and 3 range from 2.7 to 3.9, the point estimates for the 2SLS models 1 and 3 are much greater (recall that the 2SLS models 2

Table 4.3: *Marginal Benefit-Cost Ratio for a Supply Elasticity of One*

OLS Model	Point Estimate	Simulation Results: Mean	95% Lower Bound	95% Upper Bound
1*	3.0	10.2	0.3	41.6
2*	2.7	9.0	0.6	33.2
3*	3.9	18.4	0.4	49.5
4	10.3	25.2	1.1	91.1

2SLS Model	Point Estimate	Simulation Results: Mean	95% Lower Bound	95% Upper Bound
1*	29.6	14.4	0.4	71.1
2	0.9	2.0	0.3	7.4
3*	17.1	20.7	0.2	66.8
4	5.9	5.9	1.1	118.2

Notes: Models marked * were not rejected on grounds of implausible estimates or statistical problems.

and 4 were rejected in section 3.2). The point estimate for model 1 using 2SLS is 29.6, and that for model 3 is 17.1. These larger benefit-cost ratios result from both a larger promotion elasticity for CPB promotion and a smaller own-price elasticity of demand in the 2SLS models than in the OLS models.[15]

[15] The effect of the own-price elasticity is apparent when comparing OLS and 2SLS for model 2. Although the effect of CPB promotion is slightly greater in the 2SLS case, the benefit-cost ratio is considerably smaller than in the OLS model. The reason is that the larger promotion elasticity under 2SLS is offset by the very large (in absolute value) own-price elasticity of demand.

5. ANALYSIS OF TEST-MARKET STUDIES

The California Prune Board has periodically conducted test-market studies to evaluate the effectiveness of its promotional expenditures. As part of our overall evaluation of the Board's promotional activities, we performed our own analysis of data collected in two recent test-market studies. One study, conducted in 1990, involved an analysis of television advertising in three test cities, with three comparable cities monitored as controls. The other study, conducted in conjunction with Safeway stores in 1995, was an evaluation of the effect of in-store information on prune sales. These studies provide an opportunity to further our understanding of the effects of alternative types of promotion and provide a basis to confirm or contradict results from the analysis of the monthly and annual demand models. Following is our analysis of these two test-market studies.

5.1 Six-City Study of Television Advertising

The objective of this study was to estimate the effect of television advertisements on prune sales. The initial study was conducted by Nielson Marketing Research, based on the method of matched-market evaluation. Three cities were selected as test markets, where TV ads for prunes were run for 12 weeks in 1990, and three cities were selected as control markets in which no TV ads for prunes were run. The test and the control cities were selected based on similarity of volume of prune sales prior to the test, promotion history, and availability of major brands (Table 5.1).

The TV ads featured generic advertising of dried prunes. In 1990, an advertising agency was commissioned by the Prune Board to create a new advertising campaign to promote prunes. The result was a series of television commercials with the overall title "Prune Presenter." In these television commercials, a magician performed sleight-of-hand tricks to portray prunes as containing more vitamins and minerals than other fruits. Expenditures on the TV ads in the three test cities over the twelve weeks were at a rate equivalent to expenditures of $4.2 million annually in the United States.

The TV ads were run for 12 weeks in 1990, from early September to the end of November. The differences in prune sales between the test and control markets were based on sales from September 1990 to February 1991; the 12 weeks when the TV ads were run and an additional 12 weeks after the completion of the TV ads (Table 5.2).

Nielson Marketing Research conducted an initial analysis of the test market results. Their method involved first adjusting sales for the periods during and after the TV ads for any pre-advertising differences between markets, based on sales trends in the months prior to the

Table 5.1: *Test and Control Markets in the Television Ad Test Campaign*

Test Cities TV ads run	Matching Control Cities No TV ads
Denver	Omaha
Hartford	Philadelphia
Kansas City	Chicago

Source: Nielson Marketing Research.

Table 5.2: *Time Frame of the Television Advertising Test*

Earlier months; same year		Same month; previous year			
		(9/89)		(2/90)	
		Testing period			
(3/90)	(8/90)	(9/90)		(2/91)	
		TV ads run		Post TV Ad	
		(9/90)	(11/90)	(12/90)	(2/91)

Table 5.3: *Overall Effect of Television Advertisements on Prune Sales*

Market	Percentage Change	Adjustment
Ad market	+3.4	Unadjusted for pre-test differences
No-ad market	-8.3	Unadjusted for pre-test differences
Net difference	+9.1	Adjusted for pre-test differences
Total U.S.	-1.9	Unadjusted for pre-test differences

Source: Nielson Marketing Research

Table 5.4: *Effect of Television Advertisements on Prune Sales in Individual Markets*

Test Cities TV ads run	Matching Control Cities No TV ads	Net difference in prune sales – percentage –
Denver	Omaha	16.0
Hartford	Philadelphia	21.3
Kansas City	Chicago	3.4
Average	Average	9.1

Source: A.C. Nielson 1991.

TV ads, March to August 1990. Second, the percentage change in sales was computed for each city, as the ratio of adjusted sales from September 1990 to February 1991 to sales in the same 24 weeks of the previous year (September 1989 to February 1990). Third, net differences in the percentage change in sales were computed by comparing each test city and its control city. Nielson found that prune sales in the test markets were up a net 9.1 percent, relative to the test markets, when compared with the previous year (table 5.3), a result Nielson claimed was statistically significant at the 1 percent level.

The campaign's effectiveness apparently varied across the test cities (table 5.4). In Hartford and Denver sales were up 21.3 percent and 16.0 percent, respectively, relative to the control, but the sales difference in Kansas City was only 3.4% relative to its control, Chicago, and was not statistically significant.

Figure 5.1 summarizes the effects of the ad campaign on sales of dried prunes. Sales increased relative to control in the test markets in September, the first month of the campaign, but the difference then diminished in October, and adjusted sales in the test markets were actually less than in the control markets in November. However, sales in the test markets then increased significantly relative to control in the post-test months of December-February.

The results reported in tables 5.3 and 5.4 and figure 5.1 suggest a positive impact for the TV ad campaign, but our ability to draw firm inferences is hampered by confounding influences that occurred during the period of the market test. In particular, the test period coincided with a significant increase in the incidence of deals on prunes offered by the retail trade, especially in the control markets.[16] The percentage of prunes sold with a deal is shown in figure 5.2. The incidence of deals in the control markets was especially high relative to the test markets in October and November, perhaps explaining why the differential effects of the TV ad campaign diminished during those months.

The analysis-of-variance method employed by Nielson Marketing does not permit these various confounding effects to be distinguished, but, in principle, it is possible to do so using the econometric approach adopted in this study. We thus undertook an independent examination of the test market data.

Re-evaluation of the TV Advertising Test

The data for this analysis consist of monthly prune sales for nine months for each of three test-market cities and three control cities, 54 observations in all. The time period consists

[16] These deals or trade promotions included displays, cents-off coupons, and bargains such as "buy one, get a second for 50 percent off."

of three months prior to the TV ads, the three months of the ad campaign, and three months following the end of the ad campaign.

The statistical model used for this analysis is a linear model of consumer demand, similar to those used earlier in this report. In this model, the volume of prune sales at retail is expressed as a function of the price of prunes and the alternative types of promotion that were undertaken during this time in the test and control markets. An algebraic specification of the model is as follows:

$$
\begin{aligned}
Q_{n,t} = b_0 + b_1\,PRICE_{n,t} + b_2\,DISPLAY_{n,t} + b_3 PRINT_{n,t} \\
+ b_4 COUPON_{n,t} + b_5 DEAL\%_{n,t} + b_6 TV\text{-}PRIOR \\
+ b_7 TV\text{-}DURING + b_8 TV\text{-}AFTER + e_{n,t},
\end{aligned}
\qquad (5.1
$$

where $n = 1 ,..., 6$ denotes cities and $t = 1 ,..., 9$ denotes monthly time periods.

The variables used in the model are defined in table 5.5, and summary statistics for the variables are reported in table 5.6. We have data for the number of displays, print ads, the number of coupon ads, and the percentage of sales tied to a deal for both the test and control markets for the entire nine-month period of the analysis, thereby enabling us to separate these effects from any sales impacts due to the TV ads. The presence of the TV ad campaign is measured by {0,1} indicator or "dummy" variables. Thus, for example, *TV-PRIOR* assumes a value of one for a test-market city during the three-month period prior to the ads running, and is zero otherwise.

Results of the analysis are reported in table 5.7. The first column reports results for the full model as set forth in equation 5.1. Several aspects of this model are worth noting. First, the estimated price elasticity of demand is -0.57, a value quite consistent with estimates provided elsewhere in this report. Second, the effects of the TV ad campaign on demand are positive and significant, during both the test period (*TV-DURING*) and the post-test period (*TV-AFTER*). Pre-test differences in prune sales between the test and control cities (*TV-PRIOR*) are small and are not statistically significant.

DEAL%, the variable used to measure the percentage of prunes sold on a deal, also has a positive and significant effect on demand. This result is not surprising, because the deals reduce the effective price of prunes to buyers. The number of ads run with coupons also had a positive impact on sales, but the effect was not quite significant at the five percent level. The remaining two variables, *PRINT* and *DISPLAY,* have negative coefficients. These effects run counter to expectations, but they are not statistically significant, suggesting that these mechanisms had little independent effect on prune sales.[17]

[17] It is important from a statistical perspective that we consider the effects on prune demand of

Table 5.5: *Description of Variables in the Television Ad Demand Model*

Variable	Definition
$Q_{n,t}$	Pounds of dried prunes purchased per million dollars of retail purchases in city n during month t.
$PRICE_{n,t}$	Retail price of prunes in city n during month t ($/lb)
$DISPLAY_{n,t}$	Number of displays in city n during month t
$PRINT_{n,t}$	Number of A, B, or C ads in city n during month t
$COUPON_{n,t}$	Number of ads with coupons in city n during month t
$DEAL\%_{n,t}$	Percentage of sales tied with a deal, such as two-for-one
TV-PRIOR	Dummy variable equal to one for the test city n during the 3 months before TV ads were aired
TV-DURING	Dummy variable equal to one for the test city n during the 3 months TV ads were aired
TV-AFTER	Dummy variable equal to one for the test city n during the 3 months after TV ads were aired

Table 5.6: *Summary Statistics of the Variables in the Television Ad Demand Model*

Variable	N	Mean	Standard Deviation	Minimum	Maximum
$Q_{n,t}$	54	214.8	54.8	133.0	361.0
$PRICE_{n,t}$	54	1.91	0.19	1.60	2.36
$DISPLAY_{n,t}$	54	16.0	11.0	0.0	41
$PRINT_{n,t}$	54	21.1	22.7	0.0	82.0
$COUPON_{n,t}$	54	3.1	8.7	0.0	38
$DEAL\%_{n,t}$	54	10.2	10.1	0.0	40.0
TV-PRIOR	54	0.17	0.38	0.0	1.0
TV-DURING	54	0.17	0.38	0.0	1.0
TV-AFTER	54	0.17	0.38	0.0	1.0

Table 5.7: *Econometric Results: Estimated Effects of Television Ads on Prune Sales*

Independent Variables	(1)	(2)	(3)	(4)
Constant	297.36 (5.07)	298.10 (5.28)	321.81 (5.68)	322.86 (5.97)
$PRICE_{n,t}$	-64.01 (-1.93) [-0.57]	-65.71 (-2.05) [-0.58]	-78.77 (-2.45) [-0.70]	-80.85 (-2.64) [-0.72]
$DISPLAY_{n,t}$	-0.48 (-1.04)	-0.56 (-1.23)		
$PRINT_{n,t}$	-0.31 (-1.38)		-0.33 (-1.52)	
$COUPON_{n,t}$	0.71 (1.94)	0.82 (2.19)	0.62 (1.64)	0.74 (1.87)
$DEAL\%_{n,t}$	3.07 (5.83)	2.70 (5.94)	2.72 (5.58)	2.30 (5.78)
TV-PRIOR	10.7 (0.76)	13.38 (0.96)	11.18 (0.82)	13.91 (1.03)
TV-DURING	44.8 (2.90)	47.89 (3.13)	40.06 (2.96)	41.98 (3.11)
TV-AFTER	83.2 (5.31)	83.08 (5.36)	83.34 (5.55)	82.22 (5.55)
Buse R^2	0.73	0.73	0.72	0.72
Buse Raw-Moment R^2	0.98	0.98	0.98	0.98

Notes: 54 observations. t-values are in parentheses and estimated values of the price elasticity of demand calculated at sample means are in brackets. The dependent variable is $Q_{n,t}$, pounds of dried prunes purchased per million dollars of retail purchases in city n in month t.

To test for the sensitivity of these results to alternative specifications, we re-estimated the model excluding individually or in combination the insignificant variables, *DISPLAY*, *PRINT*, and *COUPON*. The results from estimating these models are provided in columns (2) through (4) in table 5.7. When *PRINT* is excluded, the effect of coupon ads is significant at the five percent level. Importantly, the effects of the variables of most interest, *PRICE* and the TV dummy variables, are little affected by the inclusion or exclusion of the other variables, thus reinforcing our confidence about those estimates.

The estimated effect of the TV ads on prune sales during and after the TV ads was positive and statistically significant at the one percent level. The TV ads increased prune sales more after the ads concluded than during the period when the ads were run. Both deals and coupons, which reduce the effective price paid by consumers, also increased prune sales. Thus, our analysis of the matched-cities test-market data suggests strongly that the television ad campaign was successful in increasing prune sales both during the test and after it. That is, even after accounting for effects of other types of promotion on prune sales, the TV ads were effective in increasing sales of prunes.[18]

Burke Marketing Research conducted two telephone surveys to measure awareness and attitudes toward prunes. A pre-wave survey was conducted in early September, prior to the TV ads, and a post-wave survey was conducted in mid-December, after the advertising campaign was concluded. Consumers in the test markets exhibited greater awareness of prune advertising after the campaign was completed (Keeble 1992), explaining perhaps the relatively greater impact of the ads on sales after the campaign had ended.

5.2 In-Store Promotion

The objective of this market study was to estimate the effect of interactive kiosks or display terminals on prune sales. Store shoppers could push a button labeled "prunes" on an interactive kiosk and follow directions to obtain recipes and to see prune advertisements. The interactive kiosks were referred to as Safeway New PICS, because they were tested in Safeway stores located in or near Phoenix.

DISPLAY, *PRINT*, *COUPON*, and *DEAL%*, but we caution against attempts to provide much interpretation of the numerical results. Although these variables all relate to various forms of prune promotion, they were not the focus of the test market study. Although we do have quantitative information on these variables from the data set generated by Nielson Marketing Research, we do not have any details on the types of displays, print ads, coupons, or deals that were in effect. Attempts to obtain this information from Nielson were unsuccessful.

[18] Unfortunately the data available from the test market do not enable us to conduct a cost-benefit evaluation of the TV ad campaign.

Table 5.8: *Test Design of New PICS at Safeway Stores*

Period	Weeks	Dates	Type of Promotion	Presence of Safeway New PICS
Base	1 - 8	June 4 - July 29		No
1	1 - 4	Aug. 6 - Sept. 2	Advertising	Yes
2	5 - 8	Sept. 3 - Sept. 30	Advertising and Recipes	Yes
3	9 - 12	Oct. 1 - Oct. 28	Advertising and Recipes	Yes

The research program consisted of 10 test stores matched with 10 control stores. The stores were matched based on similarity of total store volume, shopper demographics, and shares of urban and suburban shoppers. Retail sales were measured in each store before and during the introduction of the PICS.

The California Prune Board was one of 34 participants in the Safeway New PICS test. The promotional activities were conducted during three periods in 1995, as shown in table 5.8. The ads in period 1 were different from the ads in periods 2 and 3.

During the three test periods, the Safeway New PICS were placed in the test stores, but not in the control stores. The effect of the Safeway New PICS on sales was measured in terms of the net percentage changes in sales between the test and control stores. Over the 12-week test period, retail sales of prunes increased in both the test and the control stores when compared with the base period. The percentage difference in sales of pitted prunes in PIC stores, relative to control stores, was 19.9 percent in the first period of the program, grew to 29.2 percent in period 2 and then dropped to 21.6 percent in the third period. The average percentage difference over all three periods was 23.6 percent. The larger net percentage increases in sales in periods 2 and 3 may reflect either more effective ads or the release of recipes, or a combination of the two factors.

The number of button pushes for prunes on the New PICS declined from 2,840 in period 1, to 1,080 in period 2, and 800 in period 3. Store shoppers explored the New PICS more when they were first introduced. The high use of the PICS machines in period 1 may have contributed to higher sales in periods 2 and 3.

5.3 Conclusions from the Test-Market Analysis

The primary importance of the test-market studies is that they confirm broadly the key results contained in our primary analyses. Both the TV ad campaign and the New PICS sales promotion increased prune sales significantly relative to control markets. Both test-market studies suggest that the effects of prune promotion are rather durable. The TV ad test market study also helped to increase our confidence that the price elasticity of demand for prunes is inelastic, with estimated values in the range of -0.57 to -0.72.

6. CONCLUSION

This study has analyzed the effectiveness of product promotion in the California prune industry. The economic theory of consumer demand was used to specify empirical models to explain prune consumption as a function of prune prices, expenditures on prune promotion, and other relevant variables. Three complementary analyses were conducted. The main analysis used data for monthly intervals from September 1992 to July 1996. A secondary data set consisted of annual observations from 1949 to 1995. A third analysis evaluated the results of a test-market study of prune advertising in six U.S. cities.

The two main sources of expenditures on promotion of California prunes are the California Prune Board (CPB) and Sunsweet Growers. Results from analysis of the monthly, retail data support strongly the proposition that prune advertising and promotion has been an effective mechanism for increasing the demand for prunes. Across alternative model specifications examined and reported in part 3, prune promotion had a consistently statistically significant, positive effect on per capita domestic prune consumption. For the various models estimated using ordinary least squares (OLS), the elasticity of prune demand with respect to CPB promotion generally ranged from 0.048 to 0.052, meaning that a ten percent increase in expenditures on generic promotion would have induced about a 0.5 percent increase in consumption, holding price and other explanatory variables constant. Because of concern that some of the explanatory variables might be endogenous, the preferred model was re-estimated using two-stage least squares (2SLS). Promotion by the CPB remained a positive and statistically significant determinant of prune sales in the model estimated by 2SLS, with the estimated elasticity with respect to promotion being slightly larger than in the OLS model. The models based on the monthly data performed well against diagnostic tests, causing us to have reasonable confidence in the specification and, in turn, the statistical results pertaining to the effects of promotion.

The models based on the annual data did not perform as well. Promotion, measured in this case by annual, aggregate real expenditures by the CPB and Sunsweet on all types of domestic promotion, was generally not found to be a statistically significant determinant of demand. However, the diagnostic tests generally rejected the hypothesis that the annual models were specified correctly, reflected in dynamic effects on demand that the models were unable to capture adequately.

We used both an approximation method and a simulation approach to translate the effects of promotion on demand into estimates of marginal benefits to prune growers. Because of our greater faith in the data underpinning the monthly analysis of demand, the superior statistical performance of those demand models, and their congruence with the results from the test-market analysis reported in part 5, we based our benefit-cost analysis on results from the monthly models. The simulation analysis required a complete model of the industry, including supply response. Since a supply analysis was not a component of the present study, simulations were conducted for a range of alternative synthetic supply functions. These simulations, buttressed by some complementary algebraic derivations, enabled us to estimate the marginal returns to the industry from expenditures on advertising and promotion.

As part 4 discusses in detail, the marginal benefit-cost ratio for advertising and promotion can hinge on the value of the price elasticity of supply, depending on how the expenditures are funded. The marginal returns refer to the revenues generated from an incremental expenditure on advertising and promotion. The ratio of producer benefits to producer incidence of the check-off, however, does not depend on the supply elasticity. We emphasize this measure.

Optimal allocation of expenditures to advertising and promotion calls for expanding expenditures until the marginal dollar spent just yields a dollar back in benefits. The simulation analyses suggest that the industry stopped short of this optimizing condition during the 1992-1996 period covered by the monthly data. Considering just the models that were not rejected, the marginal benefit of an additional dollar of expenditure, given the amounts actually expended, ranged upward from $2.65, suggesting that additional expenditures on advertising and promotion would have generated positive net revenue to producers.

Only when producers are (implausibly) assumed to bear the entire cost of the promotion is it possible to derive average benefit-cost ratios less than 1:1, and this is only possible for supply elasticities of 1.0 or greater.

We conclude that promotion of California prunes conducted by the CPB has increased the demand for prunes and returns to producers of prunes. Over the four-year period analyzed in the monthly model, the results suggest that investments by prune growers in promotion through the CPB yielded them marginal returns of at least $2.65 for every dollar spent. Moreover, marginal benefit-cost ratios in the range of 2.7:1, and higher, indicate that the industry could have profitably invested even more in promotion during this period.

Appendix Table A2.1: *Selected fruit juices: U.S. Per capita consumption (in gallons)* [1]

Crop year	Citrus				Total citrus	Non-Citrus				Total noncitrus	Total
	Orange	Grapefruit	Lemon	Lime		Apple	Grape	Pineapple	Prune		
1971	3.81	0.68	0.09	0.01	4.59	0.53	0.21	0.26	0.12	1.13	5.71
1972	4.18	0.67	0.10	0.01	4.96	0.58	0.30	0.26	0.11	1.25	6.21
1973	4.19	0.71	0.15	0.01	5.07	0.45	0.19	0.25	0.07	0.96	6.03
1974	4.32	0.68	0.09	0.01	5.10	0.39	0.24	0.20	0.10	0.93	6.03
1975	4.66	0.69	0.24	0.01	5.60	0.49	0.25	0.18	0.08	1.00	6.61
1976	5.18	0.56	0.09	0.01	5.84	0.57	0.23	0.21	0.09	1.10	6.93
1977	5.01	0.75	0.17	0.01	5.94	0.52	0.22	0.20	0.11	1.06	6.99
1978	4.31	0.79	0.18	0.00	5.29	0.66	0.17	0.24	0.09	1.15	6.44
1979	4.46	0.76	0.10	0.00	5.32	0.80	0.30	0.24	0.10	1.44	6.77
1980	4.95	0.58	0.13	0.01	5.66	0.89	0.23	0.28	0.09	1.49	7.15
1981	4.72	0.72	0.25	0.01	5.69	1.08	0.25	0.30	0.09	1.73	7.42
1982	4.30	0.69	0.18	0.01	5.18	0.96	0.24	0.28	0.10	1.58	6.75
1983	5.78	0.61	0.17	0.01	6.56	1.21	0.24	0.29	0.08	1.82	8.38
1984	4.82	0.33	0.12	0.01	5.28	1.32	0.33	0.28	0.06	1.99	7.27
1985	4.81	0.61	0.15	0.01	5.57	1.53	0.28	0.27	0.07	2.16	7.72
1986	5.16	0.48	0.11	0.01	5.77	1.53	0.23	0.34	0.07	2.17	7.94
1987	5.08	0.68	0.21	0.01	5.98	1.52	0.22	0.39	0.07	2.19	8.17
1988	5.33	0.37	0.10	0.01	5.80	1.62	0.30	0.42	0.06	2.40	8.21
1989	4.63	0.60	0.11	0.01	5.34	1.60	0.26	0.42	0.07	2.35	7.69
1990	3.85	0.62	0.14	0.02	4.63	1.45	0.30	0.44	0.04	2.23	6.86
1991	4.79	0.41	0.13	0.02	5.36	1.73	0.28	0.49	0.04	2.53	7.89
1992	4.33	0.40	0.12	0.01	4.87	1.52	0.35	0.50	0.03	2.40	7.27
1993	5.14	0.59	0.17	0.01	5.91	1.57	0.38	0.47	0.04	2.45	8.37
1994 [P]	5.27	0.54	0.18	0.01	6.00	1.79	0.35	0.41	0.04	2.59	8.60

Notes: 1. Single-strength equivalent.
P. Preliminary.

Source: USDA/Economic Research Service.

Appendix Table A2.2: *Selected Commercial Fruits and Vegetables (farm weight): U.S. Per Capita Consumption (in pounds)*

Year	Fruit			Total fruit[3]	
	Fresh[1]	Processing[2]	Wine Grapes	Including grapes	Excluding grapes
1970	101.2	128.8	17.3	247.2	230.0
1971	100.3	133.5	24.4	258.2	233.8
1972	94.8	129.3	17.3	241.4	224.1
1973	96.5	131.7	27.5	255.6	228.2
1974	95.6	133.2	25.5	254.3	228.8
1975	101.8	144.5	23.9	270.1	246.2
1976	101.5	149.1	24.6	275.2	250.6
1977	99.7	163.7	25.7	289.1	263.4
1978	103.4	148.0	29.2	280.6	251.4
1979	100.1	145.0	28.9	274.1	245.2
1980	104.8	153.1	31.5	289.5	257.9
1981	103.6	152.6	27.6	283.8	256.2
1982	107.4	147.6	33.9	288.8	255.0
1983	110.0	161.0	27.3	298.2	271.0
1984	112.6	147.4	30.0	289.9	259.9
1985	110.6	152.9	31.3	294.9	263.6
1986	117.3	153.5	29.4	300.3	270.9
1987	121.6	155.5	26.2	303.2	277.1
1988	120.9	150.2	27.6	298.8	271.2
1989	123.1	141.2	25.8	290.0	264.2
1990	116.5	144.1	23.6	284.3	260.6
1991	113.2	151.7	23.0	287.9	264.8
1992	123.6	138.8	27.0	289.4	262.4
1993	124.9	153.4	24.9	303.3	278.4
1994	126.7	152.8	22.5	302.0	279.5

(continued)

Appendix Table A2.2 (continued): *Selected Commercial Fruits and Vegetables (farm weight): U.S. Per Capita Consumption (in pounds)*

Year	Vegetables					Total vegetables[3]	Total fruit & vegetables[3]	
	Fresh[4]	Canning[5]	Freezing[6]	Dehyd.[7]	Pulses[8]		Including grapes	Excluding grapes
1970	152.9	99.4	45.1	30.6	7.6	335.5	582.8	565.5
1971	146.7	106.4	46.8	31.0	7.5	338.5	596.6	572.2
1972	150.0	103.0	47.0	30.0	6.7	336.7	578.1	560.9
1973	146.6	96.7	51.9	30.6	7.9	333.8	589.4	562.0
1974	144.6	98.1	52.6	31.7	6.2	333.2	587.6	562.0
1975	147.1	96.6	54.0	32.2	7.2	337.1	607.2	583.4
1976	146.4	102.2	58.8	32.9	7.0	347.3	622.6	598.0
1977	147.0	100.6	60.5	28.9	6.9	343.9	633.0	607.3
1978	141.8	95.8	59.9	30.0	5.9	333.3	613.8	584.7
1979	146.8	99.5	56.5	29.8	6.8	339.4	613.5	584.5
1980	149.2	101.7	52.6	27.1	5.8	336.5	626.0	594.4
1981	142.8	96.3	59.1	28.3	6.0	332.5	616.3	588.7
1982	148.6	94.7	54.7	29.4	6.9	334.3	623.1	589.2
1983	148.5	96.2	56.1	29.5	7.0	337.1	635.4	608.1
1984	154.0	101.8	63.6	29.8	5.5	354.7	644.6	614.6
1985	156.2	98.9	65.0	30.4	7.6	358.1	653.0	621.7
1986	156.3	99.5	64.9	31.0	7.3	359.0	659.3	629.9
1987	162.3	98.9	67.2	29.9	5.7	363.9	667.1	641.0
1988	167.5	94.6	64.4	29.3	7.5	363.3	662.1	634.5
1989	172.3	102.2	67.6	29.9	6.3	378.2	668.2	642.4
1990	166.3	110.6	70.6	31.8	7.1	386.4	670.6	647.0
1991	163.2	113.1	73.1	32.6	7.9	389.9	677.7	654.7
1992	171.3	110.8	72.0	32.1	8.1	394.3	683.7	656.7
1993	172.0	111.7	77.5	33.0	7.8	402.0	705.3	680.3
1994	170.8	108.0	79.4	32.2	8.0	398.3	700.3	677.8

Notes:
1. Includes oranges, tangerines, tangelos, lemons, limes, grapefruit, apples, apricots, avocados, bananas, cantaloupes, cherries, cranberries, grapes, honeydew, kiwifruit, mangoes, nectarines, peaches, pears, pineapples, papayas, plums, prunes, strawberries, and watermelon.
2. Excludes wine grapes.
3. Computed from unrounded data.
4. Includes asparagus, broccoli, carrots, cauliflower, celery, sweet corn, lettuce, onions, tomatoes, artichokes, garlic, eggplant, cucumbers, bell peppers, cabbage, green beans, mushrooms, potatoes, and sweetpotatoes.
5. Includes asparagus, snap beans, carrots, sweet corn, pickles, green peas, tomatoes, potatoes, mushrooms, and miscellaneous vegetables.
6. Includes asparagus, snap beans, broccoli, carrots, cauliflower, sweet corn, green peas, potatoes, and miscellaneous vegetables.
7. Includes potatoes.
8. Includes dry peas, lentils, and dry edible beans.

Source: USDA/Economic Research Service.

Appendix Table A2.3: *Fresh Fruits (retail-weight equivalent): U.S. Per Capita Consumption (in pounds)*[1]

Year[2]	Citrus					Total	Non-Citrus	
	Oranges & Temples	Tangerines & Tangelos	Lemons	Limes	Grapefruit	Citrus[3]	Apples	Apricots
1970	15.68	2.13	1.98	0.17	7.97	27.92	16.34	0.11
1971	15.26	2.22	2.16	0.16	8.29	28.10	15.77	0.12
1972	14.04	1.96	1.79	0.20	8.31	26.30	14.91	0.08
1973	14.00	1.97	1.86	0.20	8.31	26.35	15.48	0.08
1974	13.99	2.13	1.93	0.19	7.96	26.20	15.75	0.06
1975	15.40	2.45	1.87	0.21	8.11	28.04	18.71	0.07
1976	14.30	2.25	1.82	0.23	8.98	27.58	16.40	0.09
1977	13.04	2.50	2.03	0.22	7.50	25.29	15.86	0.08
1978	13.04	1.98	2.05	0.21	8.09	25.38	17.23	0.07
1979	11.15	1.92	1.84	0.26	7.07	22.23	16.45	0.07
1980	13.85	2.10	1.84	0.34	7.08	25.21	18.43	0.09
1981	11.99	1.93	1.93	0.40	6.45	22.70	16.18	0.09
1982	11.34	1.97	1.98	0.36	6.99	22.64	16.84	0.07
1983	14.59	2.14	2.23	0.49	7.60	27.04	17.54	0.07
1984	11.51	1.97	2.07	0.43	5.80	21.78	17.62	0.11
1985	11.25	1.44	2.21	0.53	5.34	20.76	16.57	0.15
1986	13.03	1.52	2.37	0.55	5.95	23.42	17.13	0.09
1987	12.43	1.69	2.38	0.48	6.16	23.14	20.00	0.07
1988	13.48	1.68	2.37	0.53	6.49	24.56	19.04	0.14
1989	11.80	1.63	2.29	0.66	6.41	22.79	20.37	0.09
1990	12.00	1.24	2.50	0.63	4.29	20.66	18.82	0.14
1991	8.20	1.31	2.50	0.72	5.69	18.42	17.45	0.12
1992	12.52	1.84	2.44	0.98	5.77	23.54	18.48	0.14
1993	13.82	1.78	2.55	0.91	6.05	25.11	18.40	0.12
1994 P	12.67	2.01	2.57	0.93	5.91	24.09	18.77	0.16

(continued)

Appendix Table A2.3 (continued): *Fresh Fruits (retail-weight equivalent): U.S. Per Capita Consumption (in pounds)*[1]

Year[2]	Non-Citrus, cont.							
	Avocados	Bananas	Cherries	Cran-berries	Grapes	Kiwifruit	Mangoes	Peaches & nectarines
1970	0.80	17.38	0.47	0.17	2.63	na	0.07	5.53
1971	0.42	18.06	0.63	0.19	2.31	na	0.08	5.38
1972	0.77	17.92	0.36	0.15	2.29	na	0.08	3.69
1973	0.40	18.16	0.69	0.18	2.62	na	0.11	4.05
1974	0.66	18.49	0.54	0.14	2.85	na	0.12	4.12
1975	1.16	17.64	0.65	0.14	3.29	na	0.16	4.73
1976	0.68	19.25	0.77	0.18	3.22	na	0.18	4.88
1977	1.11	19.21	0.59	0.18	3.22	na	0.14	4.84
1978	1.05	20.19	0.50	0.17	2.81	na	0.20	5.79
1979	1.18	20.98	0.63	0.13	3.14	na	0.20	6.33
1980	0.79	20.77	0.64	0.14	3.61	na	0.24	6.73
1981	1.96	21.48	0.50	0.20	3.69	na	0.19	6.53
1982	1.46	22.54	0.49	0.20	5.20	0.07	0.28	5.08
1983	1.74	21.25	0.68	0.13	5.09	0.09	0.41	5.16
1984	2.06	22.18	0.66	0.12	5.54	0.14	0.41	6.36
1985	1.72	23.48	0.40	0.13	6.23	0.13	0.41	5.22
1986	1.42	25.82	0.46	0.14	6.46	0.13	0.46	5.54
1987	2.21	25.02	0.67	0.12	6.41	0.23	0.53	5.75
1988	1.49	24.29	0.50	0.11	7.01	0.23	0.36	6.41
1989	1.45	24.71	0.59	0.19	7.22	0.30	0.48	5.56
1990	1.01	24.36	0.37	0.23	7.21	0.45	0.51	5.27
1991	1.32	25.13	0.38	0.25	6.61	0.40	0.81	6.11
1992	1.35	27.26	0.50	0.23	6.54	0.30	0.64	5.72
1993	2.04	26.80	0.41	0.18	6.41	0.49	0.85	5.65
1994 [P]	1.24	28.06	0.50	0.30	6.67	0.46	0.93	5.19

(continued)

Appendix Table A2.3 (continued): *Fresh Fruits (retail-weight equivalent): U.S. Per Capita Consumption (in pounds)*[1]

Year[2]	Non-Citrus, cont.						Total	Total
	Pears	Pine-apples	Papayas	Plums & prunes	Straw-berries	Melons	Non-Citrus[3]	Fresh Fruit[3]
1970	1.80	0.67	0.11	1.40	1.60	19.50	68.57	96.49
1971	2.41	0.61	0.09	1.22	1.68	18.90	67.86	95.96
1972	2.17	0.74	0.11	1.03	1.53	18.50	64.33	90.63
1973	2.44	0.87	0.13	1.09	1.45	18.10	65.87	92.22
1974	2.36	0.86	0.15	1.43	1.68	16.00	65.22	91.42
1975	2.60	0.98	0.16	1.26	1.65	16.10	69.30	97.34
1976	2.68	1.09	0.19	1.19	1.52	17.20	69.53	97.11
1977	2.26	1.29	0.24	1.47	1.76	17.70	69.94	95.23
1978	2.18	1.37	0.24	1.46	1.95	18.20	73.42	98.79
1979	2.18	1.39	0.16	1.54	1.75	17.40	73.55	95.78
1980	2.48	1.42	0.20	1.46	1.81	16.30	75.12	100.33
1981	2.68	1.48	0.21	1.62	2.00	17.50	76.30	99.00
1982	2.70	1.58	0.16	1.01	2.18	20.00	79.85	102.50
1983	2.84	1.60	0.17	1.34	2.14	17.80	78.05	105.09
1984	2.41	1.43	0.25	1.75	2.73	21.80	85.58	107.36
1985	2.65	1.40	0.17	1.36	2.75	21.90	84.65	105.41
1986	2.83	1.64	0.17	1.23	2.66	22.40	88.58	112.00
1987	3.34	1.55	0.18	1.82	2.87	22.10	92.85	115.99
1988	3.06	1.67	0.15	1.63	3.07	21.60	90.73	115.28
1989	3.04	1.86	0.13	1.34	2.99	24.10	94.44	117.23
1990	3.06	1.95	0.17	1.47	2.98	22.40	90.39	111.05
1991	3.00	1.82	0.16	1.35	3.29	21.20	89.40	107.82
1992	2.98	1.90	0.23	1.69	3.32	23.00	94.29	117.83
1993	3.21	1.95	0.27	1.22	3.35	22.80	94.15	119.26
1994 [P]	3.30	1.94	0.29	1.53	3.68	23.70	96.70	120.79

Notes:
1. Uses U.S. total population, July 1 for everything except apples, grapes, and pears, which use January 1 of the year following that indicated.
2. Citrus fruits are on a crop-year basis beginning in year preceding that indicated. Noncitrus fruits are on a calendar-year basis except apples, grapes, and pears which are on a crop year-basis beginning in year indicated.
3. Computed from unrounded data.

na. Not available.
P. Preliminary.

Source: USDA/Economic Research Service.

Appendix Table A2.4: *Dried fruits: U.S. Per capita consumption (in pounds)*[1]

Year[2]	Apples	Apricots	Dates[3]	Figs	Peaches	Pears	Prunes[4]	Raisins	Total[5]
1970	0.11	0.06	0.26	0.22	0.02	0.01	0.69	1.35	2.72
1971	0.06	0.04	0.26	0.20	0.02	0.01	0.58	1.43	2.60
1972	0.08	0.04	0.25	0.13	0.02	0.01	0.49	1.04	2.06
1973	0.14	0.05	0.33	0.18	0.01	0.01	0.55	1.38	2.65
1974	0.11	0.03	0.26	0.16	0.01	0.01	0.51	1.29	2.38
1975	0.13	0.05	0.34	0.16	0.02	0.01	0.60	1.29	2.60
1976	0.13	0.06	0.33	0.17	0.02	0.01	0.53	1.28	2.53
1977	0.12	0.06	0.36	0.16	0.02	0.01	0.49	1.25	2.47
1978	0.12	0.04	0.34	0.17	0.01	0.01	0.43	1.10	2.22
1979	0.14	0.06	0.26	0.17	0.01	0.01	0.38	1.31	2.34
1980	0.10	0.03	0.14	0.13	0.01	0.01	0.43	1.46	2.31
1981	0.10	0.05	0.18	0.14	0.02	0.01	0.46	1.54	2.50
1982	0.11	0.08	0.26	0.14	0.02	0.01	0.42	1.52	2.56
1983	0.15	0.09	0.25	0.14	0.04	0.01	0.46	1.58	2.72
1984	0.16	0.09	0.32	0.13	0.04	0.01	0.39	1.90	3.04
1985	0.14	0.03	0.24	0.13	0.02	0.01	0.47	1.92	2.96
1986	0.10	0.08	0.15	0.14	0.01	0.01	0.44	1.83	2.76
1987	0.15	0.05	0.17	0.18	0.02	0.01	0.62	1.88	3.08
1988	0.15	0.08	0.23	0.15	0.02	0.01	0.58	2.07	3.29
1989	0.14	0.10	0.23	0.16	0.01	0.01	0.63	1.92	3.20
1990	0.10	0.07	0.23	0.20	0.01	0.01	0.97	1.80	3.39
1991	0.10	0.08	0.22	0.15	0.02	0.01	0.73	1.78	3.09
1992	0.15	0.10	0.16	0.16	0.02	0.01	0.58	1.62	2.80
1993	0.18	0.09	0.21	0.21	0.01	0.01	0.68	1.86	3.25
1994[P]	0.19	0.14	0.15	0.19	0.01	0.01	0.71	1.72	3.12

Notes:
1. Processed weight.
2. Beginning July 1 for apples, apricots, peaches, and pears; September 1 for dates, and August 1 for figs, prunes, and raisins.
3. Pits-in basis.
4. Excludes quantities used for juice.
5. Computed from unrounded numbers.
P. Preliminary.

Source: USDA/Economic Research Service.

Appendix Table A2.5: *Domestic Shipments of California Prunes*

Year	Dried Pitted Prunes	Dried Whole Prunes	Juice and Concentrate	Canned	Baby Food or Puree	U.S. Govt.	Other Human	Total Human	Stock Food
1949	657	85,615	36,582	2,912	4,288	17,074	227	147,355	207
1950	700	85,222	30,728	4,305	5,079	5,987	295	132,316	159
1951	670	86,204	31,728	2,441	3,408	1,360	61	125,872	0
1952	749	84,077	36,063	2,745	3,950	2,032	287	129,903	5
1953	902	76,162	37,769	2,306	3,687	3,565	304	124,695	1,031
1954	908	81,557	38,801	3,045	3,803	496	624	129,234	53
1955	883	70,593	40,620	4,738	3,435	na	832	121,101	378
1956	746	73,448	48,920	5,747	3,703	na	1,888	134,452	1,305
1957	833	79,596	43,560	4,426	2,589	na	1,703	132,707	1
1958	507	57,474	34,095	4,327	1,967	na	1,481	99,851	143
1959	620	60,605	41,476	4,323	2,589	na	2,005	111,618	48
1960	795	56,757	43,781	4,415	2,200	na	1,268	109,216	47
1961	1,831	56,100	42,377	3,724	2,254	na	1,599	107,885	547
1962	1,998	58,271	44,328	3,592	2,210	na	1,144	111,543	265
1963	3,206	54,760	48,454	4,295	2,200	na	2,500	115,415	576
1964	5,521	57,248	51,513	9,760	2,051	na	2,896	128,989	758
1965	7,606	53,850	54,414	8,981	2,007	na	1,911	128,769	1,224
1966	8,424	47,167	37,629	3,273	2,093	1,299	888	100,773	682
1967	12,703	44,566	44,925	3,761	2,041	213	846	109,055	1,068
1968	13,528	42,347	46,482	3,440	1,598	13,931	965	122,291	473
1969	14,978	38,030	41,415	3,345	1,782	4,076	132	103,758	443
1970	15,906	37,428	42,924	2,951	1,285	17,569	133	118,196	661
1971	19,780	40,337	42,121	2,990	1,316	11,258	53	117,855	649
1972	11,319	32,729	37,049	2,798	857	994	na	85,746	10
1973	13,671	40,137	47,798	3,764	1,304	2,011	na	108,685	430
1974	11,131	36,578	38,250	2,832	1,096	0	na	89,887	374

(continued)

Appendix Table A2.5 (continued): *Domestic Shipments of California Prunes*

Year	Dried Pitted Prunes	Dried Whole Prunes	Juice and Concentrate	Canned	Baby Food or Puree	U.S. Govt.	Other Human	Total Human	Stock Food
1975	13,994	40,487	48,157	2,706	1,161	185	na	106,690	1,025
1976	14,280	36,300	43,345	2,616	1,665	0	na	98,206	706
1977	13,626	38,309	44,289	3,385	1,191	0	5	100,805	20
1978	11,981	30,994	38,515	2,461	1,142	0	0	85,093	0
1979	11,857	30,159	42,171	2,142	1,031	0	0	87,360	0
1980	14,913	31,408	45,241	2,068	1,011	2,932	0	97,573	166
1981	15,942	31,083	39,858	1,909	789	3,711	0	93,292	183
1982	17,626	29,035	38,800	1,609	762	6,506	0	94,338	0
1983	20,080	27,270	39,715	1,785	891	3,667	0	93,408	0
1984	19,601	24,776	36,330	1,802	744	1,662	0	84,915	0
1985	23,102	25,324	35,805	1,839	707	3,536	0	90,313	0
1986	28,763	25,237	33,786	1,812	540	593	0	90,731	0
1987	33,288	23,443	40,912	1,872	683	2,828	0	103,026	0
1988	37,676	22,591	40,419	1,563	865	5,637	0	108,751	0
1989	42,234	23,580	43,103	1,668	2,074	5,058	0	117,717	0
1990	44,166	20,856	40,688	1,395	1,092	504	0	108,701	0
1991	43,059	16,707	38,128	1,280	1,168	3,964	0	104,306	0
1992	47,932	13,137	36,465	1,304	1,377	403	na	100,618	na
1993	42,171	12,269	33,207	1,406	1,502	235	na	90,790	na
1994	48,281	8,443	31,419	1,216	1,733	342	na	91,434	na
1995	46,383	9,457	35,292	1,281	1,755	288	na	94,456	na

Source: California Prune Board, Annual Reports

Table A2.6: *Expenditures by the California Prune Board*

Year	Domestic Merchand. and Pub. Rel.	Domestic Advertising	Export Promotion	Industry Research	Total
1949	15	0	0	0	15
1950	13	0	0	0	13
1951	24	15	3	0	42
1952	66	215	9	0	290
1953	68	268	18	0	355
1954	63	369	3	0	435
1955	72	331	1	0	405
1956	58	336	66	0	460
1957	120	365	63	6	554
1958	102	249	39	8	397
1959	112	286	35	7	439
1960	110	297	19	18	443
1961	115	319	52	15	501
1962	110	319	75	19	523
1963	125	299	115	10	548
1964	121	365	114	35	635
1965	159	981	142	31	1,313
1966	156	809	114	40	1,119
1967	158	848	14	44	1,065
1968	195	688	61	88	1,032
1969	156	903	39	59	1,156
1970	164	903	7	80	1,154
1971	190	1,049	7	80	1,326
1972	170	777	7	67	1,021
1973	219	2,103	93	91	2,506
1974	154	1,706	138	92	2,090

(continued)

Table A2.6 (continued): *Expenditures by the California Prune Board*

Year	Domestic Merchand. and Pub. Rel.	Domestic Advertising	Export Promotion	Industry Research	Total
1975	40	0	43	50	133
1976	0	0	0	69	69
1977	0	0	0	62	62
1978	53	0	0	67	120
1979	336	171	0	78	585
1980	302	3,299	0	90	3,691
1981	366	3,939	0	90	4,395
1982	462	3,586	0	109	4,157
1983	486	2,829	0	105	3,420
1984	576	3,771	0	88	4,435
1985	842	3,006	112	89	4,049
1986	987	2,037	595	85	3,704
1987	2,108	3,289	835	138	6,370
1988	1,539	4,697	1,055	260	7,552
1989	2,103	5,042	992	236	8,372
1990	2,326	3,191	1,050	253	6,820
1991	2,835	3,057	883	269	7,044
1992	3,020	2,905	933	312	7,170
1993	1,535	1,300	925	300	4,060
1994	2,675	3,769	940	348	7,732
1995	3,075	3,850	1,070	379	8,374

Source: California Prune Board

Appendix Table A3.1: *U.S. Dried Prune Data used in the Monthly Models (1992-96)*

obs	Week Ending	*Total Q* (lbs)	*POP* (millions)	*EXP* ($)	*PP* ($)	*PR* ($)	*PF* ($)	*PS* ($)	*PROMO* ($)	*CPI* (8-96 =1)
1	6-Sep-92	3,417,100	255.42	15,931	1.94	2.11	1.84	4.71	489,130	0.896
2	4-Oct-92	3,744,500	255.59	15,976	1.91	2.12	1.84	4.63	1,045,811	0.898
3	1-Nov-92	4,292,200	255.77	16,190	1.90	2.15	1.85	4.32	1,888,504	0.901
4	29-Nov-92	4,331,700	255.94	16,213	1.93	2.19	1.76	3.95	1,599,959	0.903
5	27-Dec-92	4,327,500	256.11	16,202	1.92	2.28	1.74	4.01	1,377,437	0.902
6	24-Jan-93	4,771,900	256.28	16,434	1.91	2.18	1.81	4.22	1,596,829	0.907
7	21-Feb-93	4,980,800	256.46	16,492	1.91	2.15	1.81	4.44	1,821,775	0.910
8	21-Mar-93	4,933,600	256.63	16,550	1.93	2.15	1.82	4.50	2,034,302	0.913
9	18-Apr-93	5,148,700	256.80	16,742	1.88	2.11	1.78	4.27	1,918,690	0.915
10	16-May-93	4,240,500	256.98	16,765	1.94	2.18	1.86	4.59	1,313,142	0.917
11	13-Jun-93	3,890,300	258.14	16,788	1.95	2.17	1.86	4.65	884,246	0.918
12	11-Jul-93	3,412,400	258.31	16,765	1.95	2.17	1.87	4.72	1,007,806	0.918
13	8-Aug-93	3,241,700	258.49	16,812	1.98	2.18	1.88	4.73	833,311	0.921
14	5-Sep-93	3,215,100	258.66	16,847	2.02	2.18	1.89	4.76	476,391	0.922
15	3-Oct-93	3,456,300	258.83	16,916	2.03	2.18	1.89	4.69	815,936	0.926
16	31-Oct-93	3,809,800	259.00	16,983	2.04	2.20	1.89	4.33	1,335,227	0.926
17	28-Nov-93	4,230,500	259.18	16,999	2.06	2.22	1.81	4.03	1,286,493	0.927
18	26-Dec-93	4,188,100	259.35	16,999	2.05	2.33	1.80	4.00	1,783,183	0.927
19	23-Jan-94	4,097,700	259.52	17,155	2.06	2.24	1.87	4.43	1,257,739	0.929
20	20-Feb-94	4,470,600	259.70	17,214	2.06	2.21	1.87	4.60	1,217,936	0.933
21	20-Mar-94	4,947,700	259.87	17,273	2.04	2.19	1.85	4.62	1,812,888	0.936
22	17-Apr-94	4,584,700	260.04	17,386	2.04	2.20	1.85	4.50	1,559,480	0.937
23	15-May-94	3,890,700	260.21	17,398	2.12	2.25	1.90	4.55	1,172,631	0.938
24	12-Jun-94	3,701,600	260.66	17,457	2.13	2.23	1.90	4.68	1,223,001	0.941
25	10-Jul-94	3,394,500	260.83	17,567	2.11	2.24	1.92	4.77	1,503,771	0.943
26	7-Aug-94	3,283,000	261.01	17,638	2.10	2.25	1.94	4.64	1,190,957	0.947
27	4-Sep-94	3,100,600	261.18	17,685	2.11	2.22	1.93	4.70	599,865	0.950
28	2-Oct-94	3,377,500	261.35	17,697	2.11	2.26	1.96	4.62	1,030,314	0.950
29	30-Oct-94	3,671,500	261.52	17,860	2.09	2.25	1.94	4.06	1,976,239	0.950
30	27-Nov-94	4,062,700	261.70	17,892	2.12	2.28	1.88	3.90	1,471,390	0.952

(continued)

Appendix Table A3.1 (continued): *U.S. Dried Prune Data used in the Monthly Models (1992-96)*

obs	Week Ending	*Total Q* (lbs)	*POP* (millions)	*EXP* ($)	*PP* ($)	*PR* ($)	*PF* ($)	*PS* ($)	*PROMO* ($)	*CPI* (8-96 =1)
31	25-Dec-94	4,042,500	261.87	17,892	2.08	2.37	1.85	3.86	2,281,549	0.952
32	22-Jan-95	3,882,100	262.04	18,115	2.10	2.31	1.92	4.17	1,600,298	0.955
33	19-Feb-95	4,722,700	262.22	18,187	2.13	2.30	1.93	4.28	1,480,893	0.959
34	19-Mar-95	4,508,200	262.39	18,248	2.11	2.32	1.95	4.30	1,967,286	0.962
35	16-Apr-95	4,470,800	262.56	18,459	2.10	2.31	1.94	4.13	1,756,616	0.966
36	14-May-95	3,743,300	262.73	18,496	2.16	2.34	1.96	4.28	1,349,716	0.968
37	11-Jun-95	3,665,900	263.03	18,532	2.16	2.35	1.98	4.31	1,366,585	0.969
38	9-Jul-95	3,341,000	263.20	18,561	2.13	2.33	1.98	4.33	1,266,180	0.969
39	6-Aug-95	3,204,300	263.38	18,610	2.15	2.33	1.99	4.25	1,022,729	0.972
40	3-Sep-95	3,044,300	263.55	18,647	2.14	2.33	2.01	4.38	785,201	0.974
41	1-Oct-95	3,285,900	263.72	18,707	2.15	2.35	2.02	4.11	1,182,914	0.977
42	29-Oct-95	3,783,700	263.89	18,742	2.13	2.34	2.00	4.07	1,719,983	0.977
43	26-Nov-95	4,081,500	264.07	18,732	2.16	2.32	1.89	3.89	1,724,766	0.976
44	24-Dec-95	4,114,400	264.24	18,719	2.10	2.40	1.87	3.93	2,216,297	0.976
45	21-Jan-96	4,052,400	264.41	19,079	2.12	2.37	1.95	4.13	2,044,989	0.982
46	18-Feb-96	4,538,000	264.59	19,140	2.16	2.37	1.96	4.24	2,015,955	0.985
47	17-Mar-96	4,486,700	264.76	19,239	2.13	2.33	1.94	4.23	2,290,121	0.990
48	14-Apr-96	4,389,600	264.93	19,313	2.12	2.36	1.95	4.00	2,051,264	0.994
49	12-May-96	3,757,700	265.10	19,397	2.16	2.42	1.99	4.33	1,193,532	0.996
50	9-Jun-96	3,392,900	265.28	19,409	2.18	2.43	2.02	4.36	1,341,806	0.996
51	7-Jul-96	3,260,300	265.45	19,446	2.14	2.44	2.04	4.30	858,772	0.998

Notes: All prices and expenditure variables are in nominal dollars. For sources, see text.

PROMO=PROCPB+PROSUN.

Appendix Table A3.2: *U.S. Dried Prune Data used in the Annual Models (1949-95)*

Year	*QS* (1000 lbs)	*AGE65* (% of POP age 65 and older)	*PP* ($/lb)	*PR* ($/lb.)	*INC* ($/person)	*POP* (millions)	*CPI* (1995=1.0)
1949	172,000	0.081	0.08	0.07	1,501	149.19	0.156
1950	172,000	0.083	0.12	0.13	1,657	152.27	0.158
1951	174,000	0.084	0.09	0.08	1,736	154.88	0.171
1952	170,000	0.085	0.12	0.08	1,806	157.55	0.174
1953	154,000	0.086	0.11	0.08	1,787	160.18	0.175
1954	164,000	0.087	0.11	0.09	1,881	163.03	0.177
1955	142,000	0.088	0.14	0.09	1,980	165.93	0.176
1956	148,000	0.089	0.10	0.10	2,050	168.90	0.178
1957	160,000	0.090	0.10	0.13	2,074	171.98	0.184
1958	116,000	0.091	0.20	0.16	2,166	174.88	0.190
1959	122,000	0.092	0.18	0.10	2,277	177.83	0.191
1960	116,000	0.093	0.20	0.11	2,335	180.67	0.194
1961	116,000	0.094	0.17	0.10	2,444	183.69	0.196
1962	120,000	0.094	0.13	0.12	2,301	186.54	0.180
1963	116,000	0.094	0.15	0.10	2,676	189.24	0.201
1964	126,000	0.095	0.12	0.12	2,860	191.89	0.203
1965	122,000	0.096	0.12	0.10	3,076	194.30	0.207
1966	112,000	0.096	0.16	0.10	3,269	196.56	0.213
1967	114,000	0.096	0.14	0.15	3,554	198.71	0.219
1968	112,000	0.097	0.15	0.13	3,839	200.71	0.228
1969	106,000	0.098	0.14	0.13	4,077	202.68	0.241
1970	106,000	0.101	0.10	0.14	4,328	205.05	0.255
1971	120,000	0.100	0.14	0.16	4,703	207.66	0.266
1972	88,000	0.101	0.27	0.28	5,217	209.90	0.274
1973	108,000	0.102	0.23	0.38	5,672	211.91	0.291
1974	96,000	0.104	0.22	0.30	6,091	213.85	0.323
1975	108,000	0.105	0.20	0.33	6,673	215.97	0.353
1976	102,000	0.107	0.21	0.35	7,315	218.04	0.373
1977	104,000	0.108	0.25	0.42	8,176	220.24	0.398
1978	86,000	0.110	0.35	0.53	9,105	222.59	0.428
1979	84,000	0.112	0.41	0.58	10,037	225.06	0.476
1980	92,000	0.114	0.34	0.60	11,132	227.73	0.541
1981	94,000	0.115	0.33	0.66	11,707	229.97	0.596
1982	94,000	0.117	0.34	0.57	12,340	232.19	0.633
1983	94,000	0.118	0.33	0.29	13,560	234.31	0.654
1984	88,000	0.119	0.35	0.32	14,421	236.35	0.682
1985	96,000	0.121	0.34	0.31	15,155	238.47	0.706
1986	108,000	0.122	0.41	0.38	15,966	240.65	0.719
1987	114,000	0.123	0.37	0.41	17,028	242.80	0.745
1988	120,000	0.124	0.39	0.45	18,147	245.02	0.776
1989	132,000	0.124	0.39	0.49	19,170	247.34	0.814
1990	130,000	0.126	0.44	0.45	19,663	249.91	0.858
1991	120,000	0.126	0.47	0.48	20,609	252.65	0.894
1992	122,000	0.127	0.51	0.42	21,224	255.42	0.921
1993	108,000	0.127	0.56	0.47	22,059	258.14	0.948
1994	114,000	0.128	0.55	0.46	23,193	260.66	0.972
1995	112,000	0.130	0.52	0.44	24,385	263.03	1.000

Notes: All dollar figures are in nominal terms. See text for sources.

Appendix Table A4.1: *Marginal Benefit-Cost Ratios for Prune Promotion: A Comparison of Means from Simulations based on Four Regressions using both OLS and 2SLS*

	Supply Elasticity				
Series	0.0	0.5	1.0	2.0	5.0
	Benefit-Cost Ratios from OLS Models				
Model 1					
Producer Benefits/Producer Costs	10.19	10.20	10.20	10.19	10.19
Producer Benefits/Total Expenses	10.19	1.24	0.79	0.47	0.21
Model 2					
Producer Benefits/Producer Costs	8.97	8.97	8.97	8.96	8.96
Producer Benefits/Total Expenses	8.97	1.12	0.72	0.43	0.20
Model 3					
Producer Benefits/Producer Costs	18.14	18.35	18.35	18.35	18.36
Producer Benefits/Total Expenses	18.14	1.26	0.79	0.46	0.21
Model 4					
Producer Benefits/Producer Costs	24.86	25.18	25.18	25.19	25.19
Producer Benefits/Total Expenses	24.86	2.24	1.41	0.83	0.37
	Benefit-Cost Ratios from 2SLS Models				
Model 1					
Producer Benefits/Producer Costs	14.28	14.42	14.42	14.42	14.43
Producer Benefits/Total Expenses	14.28	2.44	1.60	0.98	0.46
Model 2					
Producer Benefits/Producer Costs	2.01	2.01	2.01	2.01	2.01
Producer Benefits/Total Expenses	2.01	0.70	0.51	0.34	0.17
Model 3					
Producer Benefits/Producer Costs	20.39	20.73	20.73	20.74	20.74
Producer Benefits/Total Expenses	20.39	2.08	1.36	0.83	0.39
Model 4					
Producer Benefits/Producer Costs	53.23	54.24	54.21	54.20	54.20
Producer Benefits/Total Expenses	53.23	3.30	2.12	1.27	0.59

Notes: For the OLS models, estimates for model 1 are based on 7,438 replications; those for 2 are based on 7,819 replications; those for 3 are based on 7,084 replications, and those for 4 are based on 6,290 replications. For the 2SLS models, estimates for model 1 are based on 4,120 replications; those for 2 are based on 9,587 replications; those for 3 are based on 4,639 replications, and those for 4 are based on 4,535 replications. For both model types 10,000 simulations were run for each model, and we discarded those cases where a random draw chose a negative price, quantity or promotion value. Present Values are in millions of constant (August 1996) dollars using 3 percent (annual) compounding.

Appendix Table A4.2: *Marginal Benefit-Cost Ratios for Prune Promotion: A Comparison of the Lower 95% Boundaries of four OLS and 2SLS Regressions*

	Supply Elasticity				
Series	0.0	0.5	1.0	2.0	5.0
	Benefit-Cost Ratios from OLS Models				
Model 1					
Producer Benefits/Producer Costs	0.32	0.32	0.32	0.32	0.32
Producer Benefits/Total Expenses	0.32	0.21	0.15	0.10	0.05
Model 2					
Producer Benefits/Producer Costs	0.63	0.63	0.63	0.63	0.63
Producer Benefits/Total Expenses	0.63	0.46	0.36	0.25	0.13
Model 3					
Producer Benefits/Producer Costs	0.34	0.34	0.35	0.35	0.35
Producer Benefits/Total Expenses	0.34	0.22	0.16	0.10	0.05
Model 4					
Producer Benefits/Producer Costs	1.08	1.08	1.08	1.08	1.09
Producer Benefits/Total Expenses	1.08	0.77	0.60	0.41	0.21
	Benefit-Cost Ratios from 2SLS Models				
Model 1					
Producer Benefits/Producer Costs	0.43	0.43	0.43	0.43	0.43
Producer Benefits/Total Expenses	0.43	0.33	0.27	0.20	0.11
Model 2					
Producer Benefits/Producer Costs	0.32	0.32	0.32	0.32	0.32
Producer Benefits/Total Expenses	0.32	0.26	0.22	0.17	0.10
Model 3					
Producer Benefits/Producer Costs	0.19	0.19	0.19	0.19	0.19
Producer Benefits/Total Expenses	0.19	0.15	0.12	0.09	0.05
Model 4					
Producer Benefits/Producer Costs	1.09	1.09	1.10	1.10	1.10
Producer Benefits/Total Expenses	1.09	0.86	0.70	0.51	0.28

Notes: For the OLS models, estimates for model 1 are based on 7,438 replications; those for 2 are based on 7,819 replications; those for 3 are based on 7,084 replications, and those for 4 are based on 6,290 replications. For the 2SLS models, estimates for model 1 are based on 4,120 replications; those for 2 are based on 9,587 replications; those for 3 are based on 4,639 replications, and those for 4 are based on 4,535 replications. For both model types 10,000 simulations were run for each model, and we discarded those cases where a random draw chose a negative price, quantity or promotion value. Present Values are in millions of constant (August 1996) dollars using 3 percent (annual) compounding.

Appendix Table A4.3: *Marginal Benefit-Cost Ratios for Prune Promotion: A Comparison of the Upper 95% Boundaries of four OLS and 2SLS Regressions*

	Supply Elasticity				
Series	0.0	0.5	1.0	2.0	5.0
	Benefit-Cost Ratios from OLS Models				
Model 1					
Producer Benefits/Producer Costs	41.63	41.63	41.62	41.62	41.61
Producer Benefits/Total Expenses	41.63	3.11	1.72	0.95	0.41
Model 2					
Producer Benefits/Producer Costs	33.23	33.21	33.20	33.20	33.19
Producer Benefits/Total Expenses	33.23	2.21	1.19	0.63	0.27
Model 3					
Producer Benefits/Producer Costs	48.87	49.45	49.45	49.46	49.46
Producer Benefits/Total Expenses	48.87	3.08	1.70	0.91	0.39
Model 4					
Producer Benefits/Producer Costs	89.87	91.08	91.07	91.07	91.06
Producer Benefits/Total Expenses	89.87	4.64	2.49	1.31	0.55
	Benefit-Cost Ratios from 2SLS Models				
Model 1					
Producer Benefits/Producer Costs	70.20	71.12	71.12	71.12	71.12
Producer Benefits/Total Expenses	70.20	6.38	3.48	1.87	0.79
Model 2					
Producer Benefits/Producer Costs	7.44	7.44	7.43	7.43	7.43
Producer Benefits/Total Expenses	7.44	1.78	1.04	0.58	0.25
Model 3					
Producer Benefits/Producer Costs	65.73	66.82	66.84	66.85	66.86
Producer Benefits/Total Expenses	65.73	6.05	3.32	1.79	0.76
Model 4					
Producer Benefits/Producer Costs	116.04	118.18	118.17	118.16	118.16
Producer Benefits/Total Expenses	116.04	7.41	4.01	2.13	0.90

Notes: For the OLS models, estimates for model 1 are based on 7,438 replications; those for 2 are based on 7,819 replications; those for 3 are based on 7,084 replications, and those for 4 are based on 6,290 replications. For the 2SLS models, estimates for model 1 are based on 4,120 replications; those for 2 are based on 9,587 replications; those for 3 are based on 4,639 replications, and those for 4 are based on 4,535 replications. For both model types 10,000 simulations were run for each model, and we discarded those cases where a random draw chose a negative price, quantity or promotion value. Present Values are in millions of constant (August 1996) dollars using 3 percent (annual) compounding.

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