AN EVALUATION OF THE IMPACTS OF THE SUNSWEET COOPERATIVE'S ADVERTISING EXPENDITURES

by

JENA SILVA

B.S., California Polytechnic State University, San Luis Obispo, 2009

A THESIS

submitted in partial fulfillment of the requirements for the degree

MASTER OF SCIENCE

Department of Agricultural Economics
College of Agriculture

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2010

Approved by:

Major Professor
John M. Crespi

Abstract

The objective of this analysis is to develop a demand model for the Sunsweet Cooperative and from this model, determine if the benefits to Sunweet's advertising, as measured by the change in revenues, exceed the advertising costs.

Weekly retail scanner data from July 20, 2008 through June 13, 2010 were used. Ordinary least squares regression equations were estimated to determine the overall demand for Sunsweet dried prunes. Two different models were estimated, one for Sunsweet's overall prune demand and another for the Sunsweet's Ones product. The advertising elasticity for the total dried prune demand was 0.10 and for the Ones product was 0.24. The demand equations demonstrated that Sunsweet's advertising expenditures are increasing the overall demand for their dried prunes and their specific Ones product. What cannot be determined from the demand estimations is whether increase in revenues was greater than the cost of the advertising program. This is an especially important question for Sunsweet as it can be discerned from the data that Sunsweet's advertising expenditures are quite large as a fraction of its revenues when compared with other similar food sellers.

Using the regression equations, a benefit-cost simulation was conducted. We developed a measure that tells us how much the quantities sold of prunes would be affected by increased advertising expenditures by Sunsweet while taking into account the costs of advertising under an assumption of monopolistic competition. Two different scenarios were evaluated, one with a shutdown condition that did not allow average revenue to be below average cost and another without this shutdown condition. The total Sunsweet prune model resulted in an average benefit cost of 2.143 with the shutdown constraint and 1.845 without the shutdown constraint. The Ones product model resulted in an average benefit-cost estimate of 2.672 with the shutdown constraint and 2.358 without the shutdown constraint. Overall these ratios are good for a company operating under monopolistic competition and suggest that for every dollar spent on the advertising campaign, the average return was near to or greater than $2.

Overall our analysis showed that Sunsweet's advertising expenditures are increasing their overall demand and their benefits of advertising are exceeding their costs of advertising.

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Acknowledgements

I would like to thank my major professor, Dr. John Crespi for all of his help and guidance throughout this process. He really enhanced my thesis experience by challenging me and ensuring it was a learning experience. I would also like to thank my committee members Dr. Michael Boland and Dr. Tian Xia for their added guidance throughout this experience.

I would also like to thank the Sunsweet Cooperative for providing me with the data for my thesis. I would especially like to thank, Dane Lance, for taking the time to look through my thesis and get the data to me. I would especially like to thank, Gary Fong and Stephanie Harralson, for helping me obtain the correct data and taking the time to explain all of the data and industry to me.

I would like to express my gratitude to my colleagues on the fourth floor for all of their support while conducting my research. I would especially like to thank my friends and family for all of their support throughout the years, because of their strong support and encouragement I have gotten this far in my education. Without my family, I would not have been able to be as successful as I am today, I appreciate everything you have done for me.

Because of all of the individuals listed above I have been able to conduct this research and turn it into a learning experience that will benefit me for years to come.

Dedication

This work is dedicated to my Grandfather, Marvin Stowe, for the passion he had for the California prune industry and for everything he taught me.

Chapter 1 - Introduction

Today, advertising is a big part of many marketing companies budgets. There has been a lot of discussion on how much is the sufficient amount to spend on advertising and how beneficial advertising really is to a specific company. In this study, we look at the Sunsweet Cooperative and their advertising ventures to see if advertising is actually shifting their demand in a cost effective manner. In so doing we derive the demand curve for Sunsweet by using data provided by Infoscan IRI and see if their overall benefits from advertising are greater than their cost of advertising, controlling for other factors. Before examining that specific research issue, we begin with a review of the Sunsweet Cooperative and the prune industry.

Review of Industry

Sunsweet Cooperative

Sunsweet Growers, Inc. is a non-profit cooperative association. Its primary purpose is to process and market the dried fruits and agricultural products produced or delivered by its members. Founded in 1917 by California apricot and prune producers, today Sunsweet is the world's largest cooperative of prunes (Sunsweet Annual Report 2009).

As of January 2010, Sunsweet had 325 active members. A 12-person board of directors governs the cooperative. These directors are elected by the membership at the annual meeting where each member has one vote plus additional votes based on the volume of agricultural products marketed by the member through the association from the previous year. All of Sunsweet's members are divided into five districts, with at least one director per district (Lance 2010).

Sunsweet has prune dryers in ten California locations: Corning, Gridley, Hamilton City, Live Oak, Madera, Marysville, Red Bluff, River Bend, Winters, and Yuba City. The processing facility in Yuba City is the world's largest dried tree fruit processing plant. Each day 40,000 cases of Sunsweet products are processed and shipped all over the world from this facility. Yuba City is also where the executive Sunsweet office is located (Sunsweet Annual Report 2009).

Sunsweet expanded into Chile in 2006 through a wholly owned subsidiary called Agricola by building a new dryer. Sunsweet expanded its operations into Chile in order to secure fruit during crop disasters in California and to more closely monitor the rapid expansion of prune acreage there. Over the past decade the California prune industry has had crop disasters, record high field prices and high production costs due to energy, fertilizer, lack of water and reduced labor caused by immigration policies. This influenced Chile to expand prune acreage and Sunsweet to branch production out to Chile, where it felt it needed a local presence to protect Sunsweet interests and ensure Sunsweet quality standards could be met (Sunsweet Annual Report 2009).

United States Prune Production

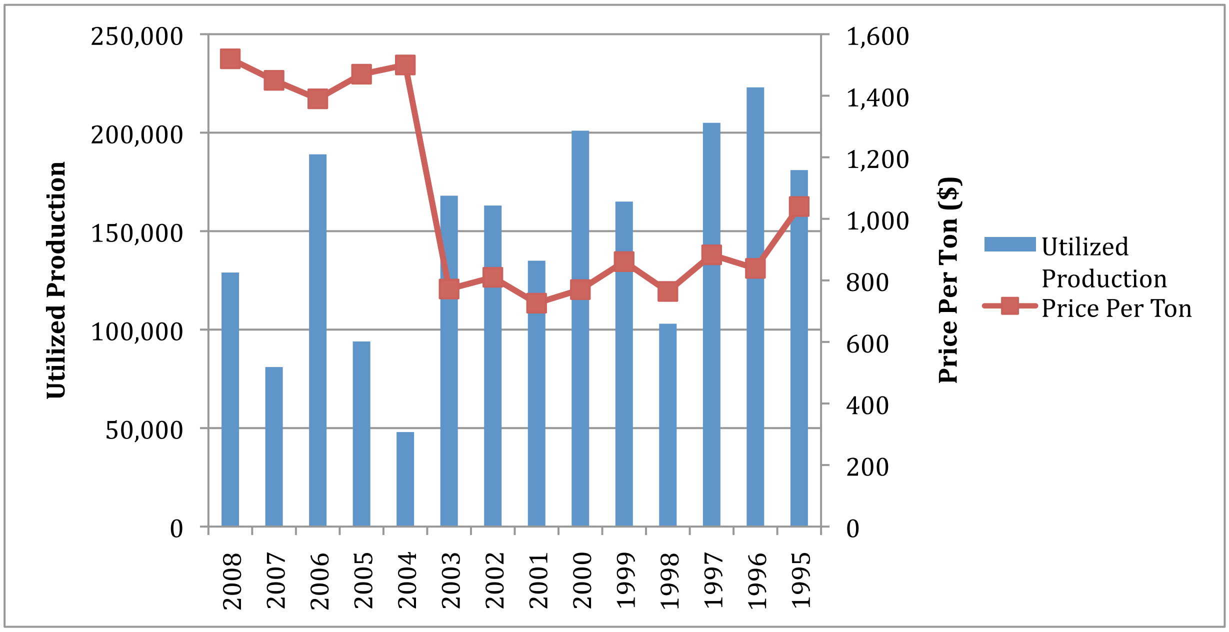
It is believed that prunes were originally domesticated near the foothills of the Caucasus region and the shores of the Caspian Sea. The U.S. prune industry originated in California when the Petite d' Agen plum from Southeast France was brought in during the 1850s where it was grafted with the American wild prune stock. In the 1870s a man by the name of John Kelsey, a Berkeley nurseryman, introduced the Japanese prune that was later hybridized by Luther Burbank (Boris 2009).

In the 1880s most California farmers had been producing apples and pears. However, due to a decline in the apple and pear industry, U.S. farmers planted prune trees, which turned out to be fairly profitable, and over time, began to export prunes. California produced 70% of the world's prune crop. Due to the large amount of production in this area, Sunsweet was located centrally in the largest prune-producing county in California, Yuba County (Boris 2009).

In the 1980s there was an increase in demand for fiber in diets. This increase, when, according to Sunsweet, coupled with intense advertising by Sunsweet, led to increased prune sales and grower returns of over $1,000 per ton. The increase in price led to California growers expanding their acreage capacity from nearly 70,000 acres to 90,000 acres. The annual tonnage soared to over 200,000 tons when global demand was only fluctuating between 165,000-185,000 tons (Sunsweet Annual Report 2009).

Most production in the U.S. is in the Sacramento and San Joaquin Valleys of California. Figure 1.1 shows the utilized tons of production and prices per ton of California prunes from 1995 to 2008. The decline in supply has been coupled with volatility in prices paid to growers as seen in figure 1.1, along with the attractiveness of growing walnuts and almonds, and the impressive possible returns from selling the land to developers (USDA 2009).

Figure 1.1 Prune Production and Dollars Paid to Producers, 1995-2008



France, Chile, Argentina, and the U.S. are the largest producers of prunes. The U.S. and France supply large domestic markets and are active in export markets as well. Chile and Argentina have virtually no domestic market. Chile exports approximately 90% of its total amount of production while the U.S. and France export about 40% of their total production (USDA:FAS 2005).

U.S. exports have declined due to many factors. The largest factor associated with the U.S. export decline is crop disasters and unavailability of product to export. The large crop disasters in the U.S. created a small supply to the foreign markets, allowing other exporters to increase their market shares. U.S. exports also decreased due to a loss of market share in the EU to Chile as a result of the EU-Chile free trade agreement. Under this agreement, the EU and Chile can trade with no import duties. U.S. dried prunes have a 9.6% tax since they are not part of any free trade agreement making U.S. import prices extremely unfavorable. The largest import market for the U.S. is the Japanese market. Another factor associated with this decline is that dried prune prices have nearly doubled in the past few years (FAS 2005).

Prunes and fresh plums are often analyzed as part of the large group of tree fruits. U.S. fruits make up a large percentage of the U.S. export market, this number has been continually increasing due to programs such as the Market Access Program and free trade agreements. The Market Access Program is a government run program that helps promote the exportation of certain commodities in other countries. The program accomplishes this through consumer promotions, market research, technical assistance, and trade servicing. This program has been important to the tree fruit export market. Dried fruits, with over 30% of the total production being exported, have the highest export level when compared to other fruits (ERS 2009). Approximately 15% of the available domestic supplies of fresh fruits are exported every year. This 15% adds up to an export value of around $3 billion a year. In the dried fruits market raisins make up about three-fourths of the market; while prunes make up about a quarter of the overall market. Japan is the largest importer of dried fruits from the U.S. importing nearly 20% of U.S. annual exports (ERS 2009).

Dried Prune Industry

The per capita consumption of prunes has been on the decline for the past few years. Figure 1.2 shows the per capita consumption of dried and fresh market plums since 1970. Frozen, canned, and fresh prunes are not shown in the figure because they are miniscule relative to dried prunes. Figure 1.3 shows a simple demand relationship for prunes.

Figure 1.2 Consumption of Fresh Plums and Processed Plums (Dried and Juice)

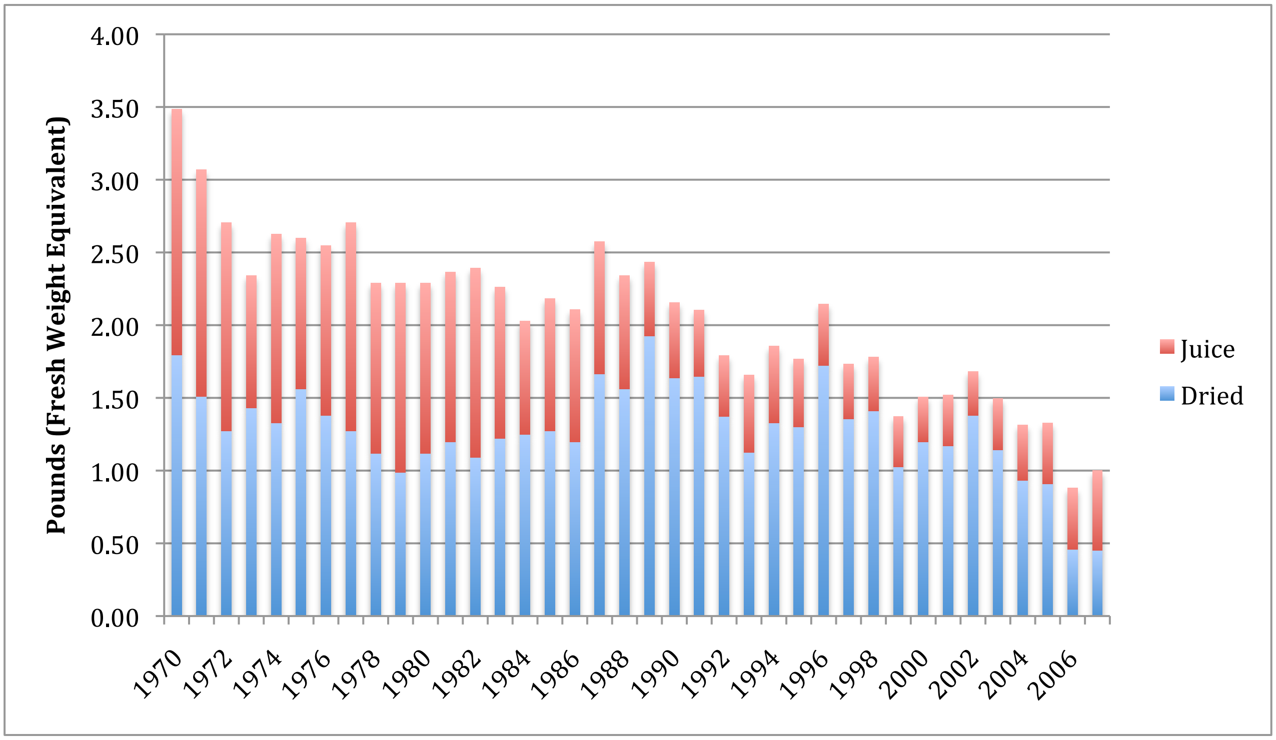
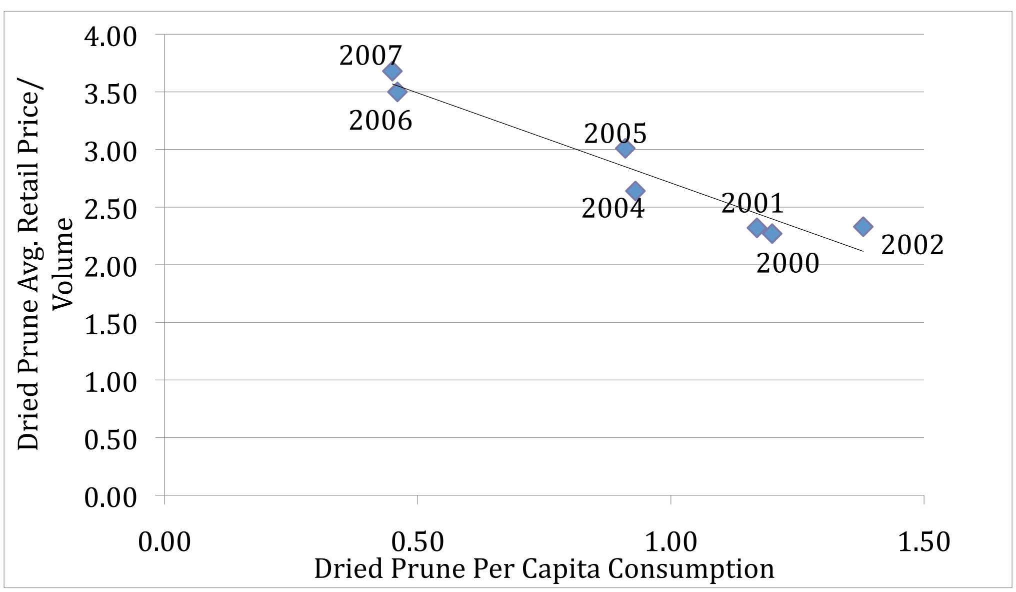


Figure 1.3 Demand Relationship for Prunes for the 2000 to 2007 Time Period



According to the USDA, 97% of prunes grown in California are of the French prune variety. This is an ideal variety for the drying process due to an optimal sugar content and its ability to be pitted. The commonly used prune for the fresh market is the Tulare Giant, which is a larger plum, which does not have the ideal characteristics of high sugar content for drying. All prunes are plums; however not all plums can be dried into prunes. Common forms you see prunes in are pitted dried plums, commonly used for snacking and baking, whole dried plums, prune juice, fresh plum juice, and fresh prunes or plums.

The fresh market plum industry is about one-third the total production of bearing acres in California. The per capita consumption of fresh plums has been fairly constant since 1970. The biggest competition for fresh market plums are peaches, cherries, and oranges. A new development of a combination of apricot and plum or a Pluot has really increased the overall fresh plum consumption. Many of the fresh prunes produced in California are shipped to other countries. The largest importers of fresh market plums are Canada followed by Taiwan, Mexico, and Hong Kong. Today, the market for fresh plums has become a very small portion of the prune industry in the U.S (Boris 2009).

The nutritional value of prunes has been found to be fairly unique. Scientists have found prunes providing potassium, soluble and insoluble fiber, magnesium, boron, antioxidants, and phytochemicals. They are very well known for their aid in increased digestive health. A study found in the *British Journal of Nutrition* suggests that consumption of prunes can lead to the reduction of atherosclerosis (hardening of the arteries) (Sunsweet Annual Report 2009).

Sunsweet has developed and promoted new products to increase the consumption of prunes. Two specific products are Sunsweet Ones that promote the nutritional value associated with prunes along with Plumsmart prune juice that is, according to its advertising, “Clinically proven to help regulate digestion.” Other new products include single serve Sunsweet Booster drinks with different specific nutritional values, an antioxidant blend, and increased ingredient use of prunes in different recipes. Another new product line is Sunsweet Naturals, organic prune products, and organic prunes, Super-fiber supplement, and herbal blend drinks. Through their partnership with ShoEi Foods, Inc., Sunsweet markets preservative free prunes in Japan.

A portion of this research focuses on the Sunsweet Ones product, which is individually wrapped dried prunes that come in a canister of approximately twenty prunes. The individually wrapped prunes promote a healthy, easily packable snack. Sunsweets' advertising budget for dried prunes has featured this particular product since 2007.

Figure 1.4 Sunsweet Ones Product

Source: Sunsweet.com

Sunsweet Faces Challenges

In 1980, Sunsweet who had already formed a sales and marketing alliance with Diamond Walnut (Diamond/Sunsweet), that helped form a combined sales organization in 1984 called Sun Diamond an organization composed of Diamond Walnut Growers, Sun-Maid Growers of California, Sunsweet Growers, Valley Fig Growers, and Hazelnut Growers. Sun Diamond was a marketing cooperative, providing sales, marketing, IT, accounting and customer service functions to its members. It was a one-stop shop for buyers to buy their dried fruit and nut products. Sun-Diamond had a big change in 1986 by becoming more decentralized. By the late 1980s, the member co-ops of Sun Diamond had each brought marketing in-house to help steer Sun-Diamond. Dane Lance, vice president of global sales and marketing, was hired by Sunsweet in 1989 to work with Sun-Diamond to develop Sunsweet's business internationally (Lance 2010).

Attractive grower prices throughout the late 1980s and early 1990s led to excess planted acreage in California and Chile, and to over-supply conditions by the late 1990s. This resulted in large and growing inventories, as prunes can be stored up to 2 years. By 2002 grower returns had plummeted to between $600 and $800 per ton, which is below the production costs for California farmers (Sunsweet Annual Report 2009).

California prune farmers responded to oversupply and unsustainable market pricing in the early 2000s with a tree-pull program in 2002 – 2003. However the reduced acreage had been more than offset by increased plantings during the same period by Argentina and Chile whose grower economies enabled them to be sustainable at lower pricing levels (Sunsweet Annual Report 2009).

Although too many acres for global demand existed, market pricing nearly doubled following California crop disasters in 2004 and 2005, and a series of below average crops in France thereafter. In response, South America, planted even more acreage (Sunsweet Annual Report 2009).

In 1999 and 2000 Sunsweet underwent organizational changes. The President of Sunsweet retired and the board hired a produce executive who had no past experience in the packaged goods industry or the prune industry. He was charged to address the oversupply issue. This decision by the board prompted the two senior Vice Presidents and the CFO to leave the company. In addition, the new President led the dissolving of Sun Diamond in 2000 due to conflicting interests amongst its members and mistrust that Sun Diamond could effectively execute the strategies of each without bias. Sunsweet was forced to build an entire sales force, logistics, accounting, and IT infrastructure overnight (Sunsweet Annual Report 2009).

In addition, the new president borrowed $40 million to launch new products while trying to create a company that could either be sold or taken public. The new products failed, the board refused to sell the company, and the president abruptly resigned. Sunsweet was left in danger of breaking bank covenants (Sunsweet Annual Report 2009).

During the 2000 to 2003 time period, Sunsweet was in a messy transition from the failed president. An interim (who then became permanent) President was elected. A plan was put in place to reduce costs. There was additional organizational turmoil as senior vice presidents brought in by the departed president changed over, including four different Chief Financial Officers. The CFO position finally stabilized with the promotion of Ana Spyres in 2003 (Sunsweet Annual Report 2009).

The interim President led the board to take action on the increasing oversupply by working with the industry and USDA to implement a mandatory tree pull program that reduced acreage by 17,000 acres in 2002. Under the program, farmers were compensated $5 per tree. The criteria for the program was that the trees had to be removed by a specific date, and they had to agree to not plant trees back until the ending date of the program, and the orchard must be capable of producing 1.5 dry tons per acre, and sufficiently farmed in the last year. This program was utilized on a large scale; nearly 17,000 acres were removed and resulted in a decrease in the amount of producing prune acres in California. This decrease accounted for nearly 23% of bearing acres in California (Sunsweet Annual Report 2009).

The board was restructured to influence more cooperation amongst the members. Sunsweet grower returns began to improve. However, Chile began planting more than 20,000 acres during this time period.

In 2004, Sunsweet's president stepped aside, clearing the path for Arthur Driscoll, the Chief Operating Officer at Sunsweet, to become President. Arthur, had come to Sunsweet to head up North American Sales in 1999, following successful career stops at Dannon, Coke Foods, and Dole. After leading the effort to build a new sales force and distribution system at Sunsweet after it had exited Sun Diamond, Driscoll, in a few short years, had become Vice President of Global Marketing & Sales and then COO (Sunsweet Annual Report 2009).

Driscoll was hired as President in 2004 with a vision for increasing grower returns and growing the company. The 2004 and 2005 crops were disaster crops for California prune producers with Sunsweet's annual volume declining from 77,000 tons to 45,000 tons (Sunsweet Annual Report 2009).

In 2009, in an economy in recession, Sunsweet has successfully navigated through the challenge by sticking with its already formed basic strategies. In 2009 Sunsweet's gross revenue surpassed $300 million dollars. They also increased their total investments in brand-building advertising and increased prune sales in the U.S. Growers received the 3rd highest grower returns in Sunsweet's history, $1,515 average net returns per ton (Sunsweet Annual Report 2009).

Current Strategic Issues for Sunsweet

Driscoll, his senior management team, and the board focused on several issues that were of great importance to Sunsweet.

1. Argentinean and Chilean Competition

Chile was now the number two producer of prunes. With cheaper labor and land prices in Chile, it was very hard for California producers to compete with the Chilean product. However, Chile tended to produce very small, low quality prunes, which in turn forced the California producer to produce larger fruit to bypass the Chilean competition. The Chilean Free Trade Agreement with the EU had many advantages and had increased the Chilean exports to the EU over the years, including prune exports. Sunsweet's operations in Chile were doing well. Many foreign markets recognized that California grown prunes tend to be more consistent and have better quality (Sunsweet Annual Report 2009).

2. Weather and its Implications for Supply

In the years 2004, 2005, and 2007 there was unexpected early hot weather that affected the pollination during the March bloom period which in turn resulted in very light crops for farmers. This occurred after many farmers had participated in the voluntary tree pull program in 2002 and led to an increase in market prices. From 2000 to 2004 prune acreage reduced from 100,000 to 75,000. Today, there are only 65,000 acres of prunes in California. This was helpful in that farmers did not have such a large supply as before the program. However, farmers were still dealing with increased supply from South America that tends to be much cheaper than U.S. prunes and a declining demand (Sunsweet Annual Report 2009).

Over the past few years the price of prunes has been considerably high, but the buyers are very particular about what they will accept and have strict regulations that if not met can result in price discounts. The farmers must have moderate crops that produce considerably large prunes. Large crops often tend to produce a lot of small prunes, small prunes get much less in price and therefore reduce profitability (Sunsweet Annual Report 2009).

One devastating result of these three bad years for the U.S. is that the supply from the U.S. was below what was being demanded in the world market, so it opened up the market to Chile and Argentina. The U.S. always had foreign competition. However, Chile and Argentina are different in that they have lower production costs and can lower the overall market price of prunes. The global dried prune crop for 2010 is predicted to be a very good one at about 170,000 tons which a 32% increase from 2008. But this figure, when coupled with existing inventories, was still 20,000 tons greater than world demand (Sunsweet Annual Report 2009).

3. Demand Factors

With new technology such as refrigeration, fresh market fruit has become a year around option and many consumers prefer fresh fruit as opposed to dried fruit. This was likely going to reduce demand for prunes. But prunes had a much lower sugar content than other dried fruits, which improved its glycemic index measure.

Current healthy eating trends have influenced increased prune consumption due to prunes high nutritional value. The ability to utilize prunes for ingredient uses such as pastries, rolls, and similar products was very limited because it was difficult to remove all of the pits from prunes. Sunsweet had invested heavily in technology to reduce the incidence of pits. But additional investment was needed for an ingredient sales infrastructure if Sunsweet wanted to sell in the ingredient market. They have also invested in large marketing campaigns that promote the healthy aspects of this fruit (Sunsweet Annual Report 2009).

4. Relationship with Customers

Sunsweet wanted to continue to emphasize branded retail items at 70 percent of total sales volume. This was only going to work if advertising was continued and marketing emphasis was placed on high specialty value-added customers. The value that Sunsweet wanted to pitch was built around its investments in proprietary operational technologies designed to reduce the incidence of pits to 25 times better than industry standard, processed as preservative free, and individual wrapped (Ones Product) (Sunsweet Annual Report 2009).

5. Sunsweet in 2010

With the projected oversupply coming predominantly small fruit (less than 92 prunes per pound), Sunsweet had determined that market pricing for small fruit would not be enough to cover drying costs. As a result Sunsweet had announced it would not pay for fruit smaller than 92 prunes per pound in order to compel its members to intensify their in-orchard grading done at harvest to screen out small sizes. It was also re-emphasizing the importance of shaker-thinning the trees in mid-May in order to improve the sizing of remaining fruit. This thinning technique, however, can only go so far. Those growers who had not aggressively pruned their trees in the winter to produce large fruit were at risk (Sunsweet Annual Report 2009).

As shown above Sunsweet like any other company has many challenges to face and one of the biggest challenges is increasing their demand and overall profits. With their advertising campaigns they are taking action to try and accomplish some form of demand shift. This analysis will look at their marketing strategies and see if they are achieving their overall goals of increasing their demand and whether doing so is cost effective.

Chapter 2 - Review of Literature

Benefit-Cost Studies

Most studies that have examined the benefits and cost of advertising of agricultural products have focused on generic commodity promotion. A study was conducted in 1998 by Alston et al. on the California Prune Board's Promotion Program looking at the economic impacts of this program. The California Prune Board is an industry association set up under the federal prune marketing order and is responsible, in part, for promoting prunes generically. Using econometric models the Alston et al. study focused on two main questions: (a) has the California Prune Boards' promotion programs shifted the demand for and sales of prunes and (b) have the producers made enough money to surpass the expenditures on promotions? In order to answer these questions the researchers set up a consumer demand model that was quantity dependent. The right hand side variables of their base model included the price of prunes, the price of prune substitutes, and total expenditures on all goods. The model was formulated to represent current prices and expenditures by dividing all variables by the Consumer Price Index for the year the study was conducted. Two different models were estimated: one using monthly data and the other using annual data. Other variables that were added to the original framework included a time trend variable, a seasonal variable, and a promotion expenditures variable. Both ordinary least squares (OLS) and two-stage least squares were used (some concerns that some of the variables in the OLS model were endogenous). A benefit cost analysis was also conducted using simulations of market conditions. From all of the analysis the study found that generic prune promotion has had a significant positive impact on U.S. prune consumption along with producer returns. The study actually suggests that the prune industry could have invested even more into promotions during this time period. This analysis is related conceptually to the analysis done in this present study.

There has always been a question as to whether generic advertising was beneficial to an industry but had differing impacts on producers. For example, if generic advertising lowered product differentiation for some producers, it could harm some while helping others. A study conducted by Crespi and Marette on the prune market uses both a theoretical and empirical analysis to answer this question. The model of product differentiation has two products one that is not differentiated and one that is; with the assumption that consumers perceive the differentiated product as a better quality product. The two products compete in the retail sector in a Bertrand style. A static game was set up where the producers could not alter the intrinsic characteristics however they could alter consumers' perceptions; through advertising and promotion. An empirical model was then estimated to look for differential effects.

The data used was California prune data. The data consisted of quantity, price, and promotion variables over fifty-two months in fifty states. The advertising variable was split into two different variables: in store advertising and national advertising. In store advertising consisted of feature only, feature and display, and display only. These variables are expressed as the cities percentage of all-commodity value (%ACV) these variables measure in terms of annual sales. %ACV's were expressed for the three main sellers of prunes: Sunsweet, Dole, and Del Monte. The generic advertising budget for the California Prune Board and Sunsweet's monthly expense on advertising can be broken down into: television and print media. In this particular study they only focused on television for this variable. A time trend variable along with a squared time trend were also included to account for any unavailable data in the study. A time-series cross sectional technique was used to estimate this model. The researchers expected a high chance of autocorrelation, heteroskedasticity, and cross-city correlation. All were checked for and found to be a problem. Generalized least squares were used to correct the first order autocorrelation, cross-city correlation, and within-city heteroskedasticity.

The elasticities derived from this model were used to interpret the data. The data showed that an increase in a brands' price leads to a decrease in its demand while increasing the other brands' demands. For each companies' advertising there was a positive effect on the demand for their product as advertising expenditures increased. The study did find some evidence that the CPB's generic advertising expenditures slightly decreased the chance of consumers purchasing Sunsweet prunes while increasing both Dole's and Del Monte's chances of being purchased.

A book was created that compiled approximately twelve different case studies that looked at commodity promotion programs in California. The book was edited by Kaiser, Alston, Crespi, and Sexton examining the structure of these programs, recent litigation, and the findings from these benefit-cost studies. The general concept behind all of the benefit-cost studies looked at is a simple supply and demand situation with added money collected from the check-off programs going into marketing in order to increase demand. Assumptions were also made with this supply and demand model; specifically Harberger's three postulates of applied welfare economics which state: 1) the area below the demand curve is total consumer benefits from the consumption of the product, 2) the areas below the supply curve is the total variable costs of production, and 3) you can add both the benefits and costs from both producers and consumers. Adding the price into these assumptions gives you consumer surplus, the area below the demand curve and above the price and producer surplus, the area above the supply curve and below the price. Adding up both producer and consumer surplus results in the total net benefit.

With this general framework in place, now assume a check-off program is enacted that requires that *k* per unit is to be collected from each producer. This will result in a parallel shift in supply of the amount *k*. The money collected from this program is used in some way such as promotion to increase demand. This shift in demand can be viewed as an increase in the consumer's willingness to pay for the commodity by *r* per unit. The result of the check off is an increase in the price to consumers of the added cost from the program to the producers and an increase in the quantity demanded resulting from the expenditures on the demand shift. Once the shifts in supply and demand are calculated the researchers focused on the change in consumer and producer surplus as a result of the check-off program.

Another way this type of analysis is conducted is through a benefit-cost ratio that is a division of gross benefits from the demand shift over the total cost of the check-off program. There are two different benefit-cost ratio measures that were used throughout all of the different case studies: average benefit-cost ratio (ABCR) and the marginal benefit-cost ratio (MBCR). The ABCR is measured by dividing the producers gross gain, which is typically the producers change in producer surplus by either 1) the reduction in producer surplus as a result of the program being enacted or 2) the total promotion expenditure. Ultimately this measure tells you if the program is profitable. The MBCR instead compares the costs and benefits caused by small variations in the magnitude of the program. Ultimately this program is telling you if you would be better off by increasing the magnitude of the program or not; if MBCR >1 you would increase the size of the program and if it was less than one you would reduce the size of the program. This model is solely for effects of a check-off program that has occurred in a single period. If the analysis were to be of a model that is of a more precise break-down such as monthly instead of annual the effects of the program may extend into other periods; this would result in the need of an aggregation of the benefits and costs over time.

As stated before there were multiple case studies that used this overall concept to deduce conclusions about the different check-off programs implemented for many California crops. Each study used the general supply and demand case as described above. Each study used different parameter estimates to calculate the different supply and demand shifts caused by the program enactment. All of the studies were *ex post* and used historical time-series data and econometric methods to approximate parameters to describe the demand shifts associated with promotion. As noted above some of the studies used ABCR and other used MBCR; therefore direct comparisons of results from these two different benefit-cost analyses cannot be done. Along with the two methods being used some researchers used change in producer surplus as their benefit measure and total expenditures on the program as their cost measure. While others used producer expenditures on the program as opposed to the total expenditures on the program. The latter was decided to be the best measure for the benefit-cost ratio of producer benefits. Ultimately the MBCR measure gives you a comparative static result that can inform a board whether increasing or decreasing the size of its check-off program is warranted while the ABCR tells whether the program has paid for itself. The analysis in this current study will be more closely related to the ABCR method.

Focusing on the findings in the case study for the California Dried Plum Board (CDPB), a board that operates under a state marketing order that funds research and generic promotion for California dried prunes. The overall goal of the prune case was to look at their promotion program and see if the demand shift from the promotions and the revenues gained by producers from the program offset the costs of the program. Using monthly data the researchers developed an econometric model of demand for California dried prunes. They found an elasticity of demand with respect to promotion of 0.05 for CDPB and 0.16 for Sunsweet. An economic simulation model of the prune industry was developed to put the demand shifts into a unit of economic return. Simulation analysis was estimated and the researchers found an MBCR of 2.65 showing not only profitability but suggesting that the industry could have spent more on promotions over this period and been more profitable than what they were.

For nearly all of the case studies evaluated the benefit-cost ratios were over one meaning that the programs were profitable for the industry. While most of the studies used different variations of benefit-cost ratios and made different assumptions, the overall conclusion was that these programs are working.

Scanner Data

There have been many studies that use electronic scanner data to analyze consumer demand. A study conducted by Capps and Love (2002) looks at using this data for demand analyses. Scanner data is very detail oriented and allows for products to be analyzed by size, brand, variety, and so on. This data can be broken down into national, regional, daily, weekly, monthly, or yearly data. Due to all of these different factors multicollinearity issues tend to arise. These issues can be avoided by aggregation of products, however you must find the right amount of aggregation. Elasticities are a huge comparison between different aggregation estimates. There are two main types of elasticities that are looked at aggregated commodity demand elasticities and firm-level elasticities.

The question is what elasticities tell the true story? Capps and Love look at this question by using data from fifteen fruit juice and drink products focusing on chilled and shelf stable drinks. The data is broken down into a weekly basis. From these data they use two different analysis approaches: multi-stage budgeting and separability. Multi-stage budgeting focuses on consumer' utility maximizing decision processes. The consumers' incomes are broken down into buying decision processes. This model is criticized due to the grouping decisions of the income variable. Separability is an analysis that breaks down the products into separate groups with similarities in each group. Their main focus is to group the products together that would have high substitutability amongst one another. Their analysis showed that these two different types of analyses did not have much differentiation between their elasticity measures; however the significance levels on separability are higher. Overall they found these models to be very similar and suggest that the more disaggregation you can obtain the better the information the elasticities present.

Product Differentiation

There has been a lot of discussion pertaining to product differentiation and monopolistic competition and their welfare implications. A study conducted by Michael Spence (1976) looks at these two different concepts and the positive implications they have on firms. Differentiation is unique in that it has increasing returns to scale which decrease average costs of different activities of the firm. In order to measure the welfare of differentiation Spence looked at the benefits to consumers plus gross revenues minus production costs.

The selection of products is affected by many different market implications. First profits and net surplus: with no price discrimination, the net surplus of a product will be greater than the profits earned from the product. However, this is only true in the presence of increasing returns to scale. Secondly, in monopolistic competition prices are set above marginal costs and entry continues until zero economic profits are obtained (price is equal to average cost). Thirdly, the elasticities of each product have a direct impact on the products net surplus and profits. Fourthly, interaction among products must be considered. The degree of substitutability of each product to another affects the slope of the demand. If there is high own-price elasticity coupled with high cross-price elasticities, the firms will produce further away from where marginal cost is equal to price and lead to more room for entry; ultimately too many products being in the market. New entry into the market has several implications, demand for the existing products decreases, consumer surplus increases, and surplus for the other producers decreases. The fifth criterion is that while profitability may not be the best measure for entry, it is the only measure available. Ultimately the idea of product differentiation is looking at a monopolistically competitive industry and maximizing the surplus subject to the fact that all firms are profitable. The last criterion is complementary products; overall Spence suggests products tend to be undersupplied.

Spence continues on with a numerical example to elaborate on the above interaction effects and to show that the non-marginal cost pricing of the products is only a fraction of the total welfare loss. He uses the inverse demand of the *i*th product x_i:

$$p_i = a - 2bx_i - 2d\sum_{i \neq j} x_j$$

With a cost function for the *i*th firm:

$$F + cx_i$$

Where c is one, a and b are the intercept and slope of the inverse demand of each product, d is the interaction effect, and F is the fixed costs. Surplus is calculated for the different number of firms. From this the equilibrium optimum and constrained optimum (which uses the equilibrium number of firms and sets the price of the goods at marginal cost). From these calculations Spence was able to conclude that too few products are produced when cross price elasticities are low when compared to own-price elasticities and fixed costs are high. He also found that often the non-marginal cost pricing is usually less than one-half of total welfare loss. Lastly when cross elasticities are high, fixed costs are low and visa versa.

Overall Spence concluded that to study product differentiation the first step in the process is to estimate the demand for the products being observed. Rather these products are existing, hypothetical, or potential the best way to develop their demand is through deriving the functional form of their demand based on their attributes such as price, physical characteristics, service, and so on. From these functions one can begin welfare analysis of differentiation in the market.

Consumers today demand variety and variety is what they get. However producers have to find that optimal amount of variety that maximizes their profit potential while offering consumers the right amount of variety, with the decreased scale economies or increased per unit costs due to producing a smaller amount of one specific product. A survey of these issues was conducted by Kelvin Lancaster (1990). He looked at the optimal amounts of variety that should be supplied by a producer in different market structures. In order for variety to be considered one or more of these four characteristics must be met: (1) variety is sought by each consumer, (2) differing tastes lead to demand for different varieties (3) adoption of variety by a firm increases its profits, and (4) profits can be made by a firm by differentiating its product from its competitors' products.

In looking at different studies that analyze these four criteria, Lancaster found three studies that had contradicting ideas of how monopolistic competition leads to optimal or non-optimal amount of variety. In Lancaster's survey he analyzed three different articles that had differing ideas about monopolistic competition, these articles included Chamberlin (1933), Dixit and Stiglitz (1977) and his own Lancaster (1979). Lancaster found that Chamberlin (1933) believed that monopolistic competition would in fact lead to more variety than what would be the optimal amount. However, Dixit and Stiglitz (1977) concluded that monopolistic competition would actually produce too few products or variety. Lancaster himself (1979) found that monopolistic competition could do both, either create too much or too little variety depending on the circumstances.

The Chamberlin model uses a specific type of firm, a monopolistically competitive firm. The firm is in a specific group of firms that share similar costs and production practices and have strong demand substitutability among one another. However, this substitutability is evenly distributed amongst the firms. The number of firms or the amount of variety in this market is determined by the free entry aspect. Every entry introduces another brand into the market, which overall causes a shift down in demand for the firms. Entry terminates when the demand curve is tangent to the average cost curve of the firms and marginal revenue is equal to marginal cost. The amount of product variety is determined in this market by two main concepts: (1) the smaller economies of scale in output the more firms and products (2) the more vigorous differentiation the steeper the demand curve and less price effect, the more firms in the market. Overall he found the more differentiation the further from the optimal amount of variety for the firms.

The Dixit and Stiglitz (1977) model looked at the same type of firm, but looked at utility curves instead, ultimately they factored in the benefits of variety. They looked at maximizing the utility functions of the consumer. They found the opposite results of Chamberlin that monopolistic competition produced too few products.

Overall from his review Lancaster found that variety in any type of market depends on three specific circumstances: (1) the larger the scale economies of output production the less variety produced, (2) the more differentiation between the products the more variety supplied, and (3) the more competition in the market the more variety supplied.

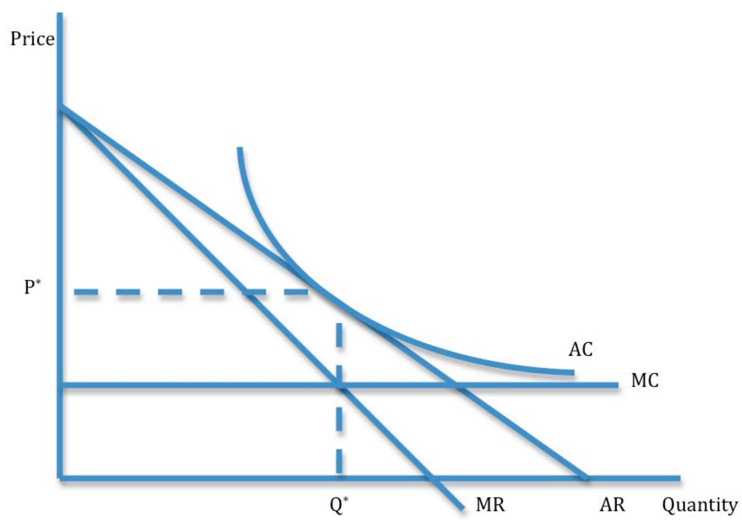
Monopolistic Competition – Differentiated Product

The theory of monopolistic competition is an important component of this thesis and, thus, some time should be spent discussing it in general. Monopolistic competition occurs when a firm is acting partially as a monopoly in that it has market power over a differentiated product and partially as a perfectly competitive firm in that it is producing where marginal revenue is equal to marginal costs, but price equals average cost, or with zero economic profits in the long run. In this market there is free entry and each firm faces a downward sloping demand curve. Market power is defined as an ability of the firms to raise prices above marginal costs, however they still make zero economic profits in monopolistic competition because the average revenue curve eventually shifts to be parallel to the average cost curve (Carlton and Perloff 2005).

Monopolistic competition is defined by O'Sulllivan and Sheffrin (2001) as "a market serviced by dozens of firms selling slightly different products." There are multiple firms because there is typically small economies of scale, which allows for both large and small firms to operate at about the same average cost and be profitable. The firms also typically offer slightly differentiated products. They achieve this differentiation by either location, services, physical characteristics or through the image of the product (i.e. advertising) (O'Sullivan and Sheffrin 2001).

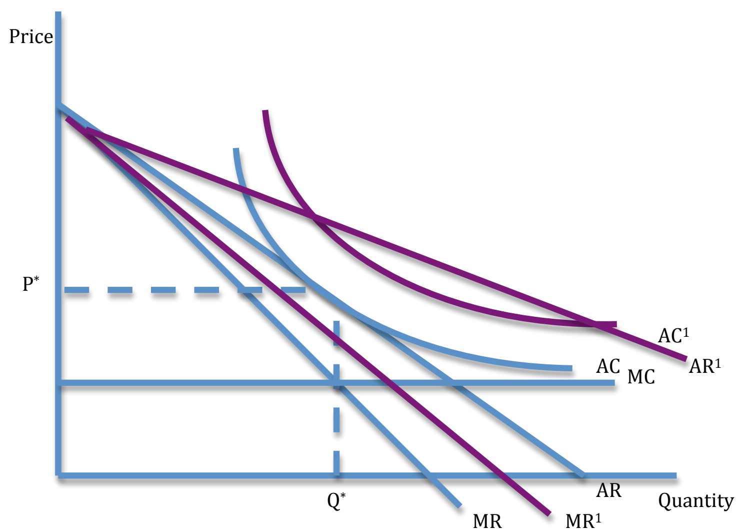
A typical marginal revenue and average cost graph for monopolistic competition is shown below (Figure 2.1), this shows the typical demand curve (average revenue) with a constant marginal cost (MC) curve. In equilibrium the firm is producing where average revenue (AR) is tangent to average cost (AC), also where marginal revenue (MR) is equal to marginal cost (MC) resulting in price being greater than marginal cost but equal to average cost for zero economic profit.

Figure 2.1-Monopolistic Competition



As we will show, the demand we estimated for Sunsweet is downward sloping, consistent with a price setting firm or a "monopoly" of a differentiated product, downward sloping and rather steep. A past study conducted by Alston et al. (1998) found Sunsweet controlled about 70 percent of retail sales with only two other major competitors present. In the last decade the number of competitors has increased and Sunsweet's market share has declined to approximately 58 percent suggesting that there are or were profits being made and entry into the market has occurred consistent with a story of increasing product diversity under monopolistic competition but inconsistent with a story of homogeneity under perfect competition as prices vary significantly among the brands. Today, there are five competitors and Sunsweet also strives to differentiate its product, which is supported by the steeper demand curve because of less substitutability, giving them the ability to raise its price above that of its rivals without losing all of its customers. Sunsweet could be seen as trying to take advantage of its average revenue being higher than its average cost in the short run. In the long run other competitors will act to push the average revenue curve down to where it is tangent to the average cost curve. Figure 2.2 illustrates where Sunsweet is functioning in the short run, if the industry is monopolistically competitive.

Figure 2.2 Monopolistic Competition in the Short and Long Run



The interpretation of this graph is that initially Sunsweet is operating where average revenue is greater than average cost, the purple lines. Other firms will see this and realize there are profits to be made in the prune industry. Once they realize this, they enter the prune market, which will decrease the average revenue received from Sunsweet shifting the average revenue curve to AR^1 until average revenue is tangent to a new lower average cost, where no economic profits will be made. At this point, no new competitors will enter the market. As a test of this assumption is difficult without very good cost data, we assert that the story of product differentiation and product variety over the last decade in the prune industry is consistent with a story of monopolistic competition in the long run.   In the remaining chapters, we use this assertion to build a model that simulates the recent prune market and can be used to ascertain whether Sunsweet's advertising expenditures have been able to provide the cooperative, on average, with returns above its long-run average costs.

Chapter 3 - Data

Sunsweet Total Dried Prunes

The data used for this research are weekly data ranging from July 20, 2008 through June 13, 2010, resulting in 100 observations. Most of the data are provided by Sunsweet. The model was heavily influenced by the evaluation of the California Prune Board's Promotion Program conducted by Alston et al. (1998) as described in more depth in the review of literature in chapter 2. Specifically the data are as follows:

Quantities: The data used for the quantity of prunes variable (*QP*) were provided by Sunsweet from their Infoscan IRI database, which represents approximately 86 percent of Sunsweet total sales. The variable represents the total pounds of Sunsweet dried prunes consumed in the U.S. for the specified week.

Prices: There are multiple price variables (*SunP, SubstP, PLP, SMP, MP, DMP, CP*) used in this model. The *SunP* variable represents the average price per pound of Sunsweet prunes. This is the weighted average of the average promoted price per pound and the average non-promoted price per pound for that week, and hence reflect any price discounts given at the retail level. These prices were also provided by Sunsweets' Infoscan IRI database, and were converted to 2010 dollars using the Consumer Price Index found on the Bureau of Labor Statistics website. These data were then multiplied by an average markdown percentage of 59%, an estimate provided by a Sunsweet analyst, to convert retail prices to Sunsweet's estimate and its received price (Fong 2010).

The *SubstP* variable was calculated taking an average of the price per pound of five of Sunsweets' main competitors. The competitors are: Champion, Del Monte, Mariani, Private Label, and Sun Maid. This variable was also adjusted to be in 2010 dollars using the Consumer Price Index (CPI). This variable was also multiplied by the 59% markdown to convert the retail prices to processor prices. While this markdown is technically only for Sunsweet. We did not have access to this kind of information for all of the competitors so for consistency we used the same percentage variable.

Private Label Pricing (*PLP*), Sun Maid Pricing (*SMP*), Mariani Pricing (*MP*), Del Monte Pricing (*DMP*), and Champion Pricing (*CP*) are the individual retail prices of each competitor. These prices were also found using Sunsweets' Infoscan IRI database. All variables represent the weighted average price per pound of prunes. This average consists of the average promoted price per pound and the average non-promoted price per pound for that week weighted by the share of sales in these weeks. These prices were also converted to 2010 dollars using the Consumer Price Index found on the Bureau of Labor Statistics website. These data were then multiplied by the percentage of 59% to get the average price to the processor.

Income: An income variable (*Income*) was used in the model, found at the Bureau of Economic Analysis. The variable used was quarterly data of per-capita personal income. This variable was also adjusted to real 2010 dollars using the CPI.

Seasonal: It has been found that consumption of prunes varies by season (Alston et al. 1998). In order to take this into consideration, seasonal dummy variables were used. The seasons were Summer (July-Sept.), Spring (April-June), Winter (Jan-Mar), and Fall (Oct-Dec), with fall being used as the base season. The variables were named *Sum, Spr*, and *Win* respectively. The seasonal dummy variables are one for each month during a given season and zero otherwise. If the weekly period ran between two seasons the one with the majority of days in the season was assigned to that season.

Total%ACV – These variables are defined as the Percentage All Commodity Value of retail stores and measures the trade merchandising "reach" and "depth" of support; percentage of stores (in terms of annual sales) that sold the product with any sort of merchandising (features, displays, or price reductions) during the specified time period. As described by Crespi and Marette (2002) these variables are "roughly dummy variables weighted by store size that show whether a particular promotion was occurring in a store at time t." These variables are broken down into display, feature, and feature and display. A feature is a product promotion without a display such as newspaper advertising or a store mailing. A display is a promotion using an in-store display without being otherwise advertised at or by the store. Feature and display is a combination of both of these methods. A total %ACV was also created that was a summation of both Sunsweet and all of its competitors' %ACV measures. A model was estimated with this %ACV measure represented individually for each player in the market. However multicollinearity issues arose so we chose not to use these variables in the broken down form and the total %ACV variable was used instead. Since prices already reflect price promotions we did not use any %ACV measure that included price promotions. The %ACV variables essentially proxy firm expenditures on marketing excluding adverting expenditures and can be best thought of as representing "promotion" but not advertising.

Sunsweet Advertising – The variable, (*SunAdv*), was constructed using budget numbers for all advertising done by Sunsweet. In consultation with the marketing department of Sunsweet growers. *SunAdv* is weekly expenditures based upon Sunsweet's advertising schedules. Over the two-year period the advertising occurred from September through May in three week increments with about two weeks separating each of these increments. The weekly expenditures were also weighted by the amount of gross rating points assigned to that particular week. In order to account for some expenditures meeting Sunsweet's customers of a larger target audience than other expenditures of the same dollar value. Like all dollar variables in this research the variables were also adjusted to real terms for 2010, using the CPI.

Lags -There were also five lagged advertising variables (*SunAdv1-SunAdv5*) put into the model to take into account delayed reactions to the advertising campaigns. In other words they are accounting for a person seeing the ad one week and then actually purchasing the prunes in later weeks. The lags ranged from one week to five weeks.

We also estimated a model with *QP1* on the right hand side of the equation. This variable is a lag variable for the dependent variable (*QP*) of the model. This variable was used for reasons discussed later in the regression analysis section to examine and distributional lag of the advertising variable.

Trend: A time trend variable was added to the model. This trend variable was simply a numbering of each observation from 1 to 100. This variable was used to account for other factors affecting prune consumption that we do not have in our model. For example prune consumption has been on a continual decline, so we may expect the sign of this variable to be negative if no other variables in our model correlate with this decline. A trend variable is also used in the Alston et al. (1998) study.

Table 3.1 provides a detailed listing of the variables used. Table 3.2 presents summary statistics for all variables in the models.

Table 3.1 Description of Variables

Variable	Definition	Units	Data Source
Time	Weekly	One observation is one week	
QP	Weekly volume sales of Sunsweet dried prunes	Pounds	Sunsweet Infoscan IRI Database
QP1	One-period lagged dependent variable	Pounds	Sunsweet Infoscan IRI Database
SunP	Average price of Sunsweet dried prunes to the retailers	Real dollars (2010) per pound of dried prunes	Retail prices came from Infoscan IRI data provided by Sunsweet and were calculated by the markdown figure provided by Sunsweet and were deflated by CPI from the Bureau of Labor Statistics
SubstP	Average price of dried prunes for all competitors in the market	Real dollars (2010) per pound of dried prunes	Retail prices came from Infoscan IRI data provided by Sunsweet and were calculated by the markdown figure provided by Sunsweet and were deflated by CPI from the Bureau of Labor Statistics
PLP	Average retail price of Private Label dried prunes to the retailers	Real dollars (2010) per pound of dried prunes	Retail prices came from Infoscan IRI data provided by Sunsweet and were calculated by the markdown figure provided by Sunsweet and were deflated by CPI from the Bureau of Labor Statistics
SMP	Average retail price of Sun Maid dried prunes to the retailers	Real dollars (2010) per pound of dried prunes	Retail prices came from Infoscan IRI data provided by Sunsweet and were calculated by the markdown figure provided by Sunsweet and were deflated by CPI from the Bureau of Labor Statistics
MP	Average retail price of Mariani dried prunes to the retailers	Real dollars (2010) per pound of dried prunes	Retail prices came from Infoscan IRI data provided by Sunsweet and were calculated by the markdown figure provided by Sunsweet and were deflated by CPI from the Bureau of Labor Statistics
DMP	Average retail price of Del Monte dried prunes to retailers	Real dollars (2010) per pound of dried prunes	Retail prices came from Infoscan IRI data provided by Sunsweet and were calculated by the markdown figure provided by Sunsweet and were deflated by CPI from the Bureau of Labor Statistics
CP	Average retail price of Champion dried prunes to retailers	Real dollars (2010) per pound of dried prunes	Retail prices came from Infoscan IRI data provided by Sunsweet and were calculated by the markdown figure provided by Sunsweet and were deflated by CPI from the Bureau of Labor Statistics

Continued.

Table 3.1 Description of Variables – Continued

Variable	Definition	Units	Data Source
Income	Yearly average personal income	Personal income by quarter in real dollars (2010)	Income came from the Bureau of Economic Analysis and was adjusted by CPI
Trend	Time trend	1,2,3,……100	
Sum, Spr, Win	Summer, Spring, Winter Dummy Variables Respectively		
Total%ACV Disp/Feat/FD	Percentage all commodity value of retail stores with a feature, display and feature and display respectively for all players in the market	Percentage	The %ACV values came from Infoscan IRI data provided by Sunsweet
SunAdv	Total weekly expenditures on Sunsweet advertising weighted to gross rating points	Real dollars (2010) per week of advertising	Budget numbers provided by Sunsweet and adjusted by CPI
SunAdv1,2,3,4,5	A lag variable of advertising expenditures	Real dollars (2010) per week of advertising	Budget numbers provided by Sunsweet and adjusted by CPI

Table 3.2 Summary Statistics in Regression Models

Variable	N	Mean	Standard Deviation	Minimum	Maximum
QP	100	316,937.800	56,280.370	233,156.100	470,326.000
SunP	100	2.572	0.169	2.059	2.771
SubstP	100	2.142	0.063	1.958	2.265
PLP	100	1.839	0.042	1.697	1.930
SMP	100	2.640	0.056	2.504	2.773
MP	100	1.946	0.113	1.462	2.153
DMP	100	2.084	0.164	1.183	2.292
CP	100	2.204	0.160	1.328	2.454
Income	100	35,915.880	314.007	35,158.450	36,531.110
Trend	100	50.500	29.011	1.000	100.000
Total%ACVDisp	100	31.424	4.410	20.824	40.144
Total%ACVFeat	100	3.264	1.962	0.562	10.198
Total%ACVFD	100	0.925	0.742	0.036	4.249
SunAdv	100	197,758.210	271,425.470	0.000	592,500.770

Sunsweet Specific Product – Ones

Another regression analysis was conducted that focused solely on the Sunsweet Ones Product. This product is the specific product currently targeted by Sunsweet's prune advertising. In order to see the direct effects of advertising on the One's we ran regressions with the quantity of ones (*QOnes*) sold weekly as our dependent variable as opposed to the total dried prunes figure. A variable representing the weekly weighted average price of the One's product (*OnesP*) was added to the right hand side of the equation. All other variables used in the model are the same as the above regression analysis. The *QOnes* variable is a weekly quantity of Ones product sold by Sunsweet, found in the Infoscan IRI Database. The mean for *QOnes* is 36,614.20 pounds with a standard deviation of 11,791.22 pounds and a minimum of 15,864.08 and a maximum of 58,734.84 pounds. The *OnesPrice* variable was also found in the InfoScan IRI Database and was converted to real dollars using the CPI and multiplied by the 59 percent variable to make it a processor price. The mean for *OnesPrice* is $3.54/pound with a standard deviation of $0.1060/pound and a minimum of $3.30/pound and a maximum of $3.74/pound.

Data Limitations: There were a few limitations to the data used and the data available. One limitation is that we do not know how much other firms are spending on their advertising. However we do know that most of the firms do virtually no advertising for prunes, except for what is done by the Prune Board with generic advertising (Lance, 2010). We did not have access to data on the generic advertising for prunes that is conducted by the California Dried Plum Board. The data were also time specific, only two years. Future analyses should attempt to control for these variables.

Chapter 4 - Demand Regression Results

Sunsweet Total Dried Prunes

In this section, different regression equations are presented that represent the weekly demand for Sunsweet's total dried prunes in the U.S. There were many variations of these equations that were examined and a representative sample of four equations are discussed. Ordinary Least Squares (OLS) was used throughout the study.

Percent ACV Measures: Percent ACV data were available for all of the different players in the market and multiple models were tested; however it was found that running regressions with all of these variables broken down by each competitor presented many multicollinearity problems amongst the variables. For this reason these models are not presented. It was decided to use an aggregated number for each %ACV measure, *Total%ACVFeature, Total%ACVDisplay*, and *Total%ACVFD* were used as our promotion variables. The multicollinearity is mostly limited to the firm-specific %ACV variables and using the aggregate form did not significantly affect other parameter estimates.

Functional Form Choice: Different functional forms were explored in the regression analysis. All models presented below were also estimated using the variables in their natural logged form; however it was found that the log models did not result in any importantly different outcomes than the linear model that was chosen. Elasticities, at the averages for the data, in the linear model were nearly identical to the constant elasticities provided by the logged models, for example. A model was also estimated using a square-root of the advertising variable to account for potentially diminishing marginal returns to promotion, which was used in the models estimated by Alston et al. (1998). Again, this variable presented no different economic results that were important so it was not used in the final selection. Different amounts of advertising lag variables were also considered. We started with only four lag variables. However we found that increasing the amount of lags from four to five was beneficial to the model results indicating the advertising was affecting demand as late as five weeks after its release but additional lags did not seem to make much difference. An interaction term (P*Adv) was also used in order to see if the demand curve was in fact rotating as opposed to shifting. What was found was that the curve became more inelastic shifting and rotating in the way that we would expect; however there were multicollinearity issues that arose due to the six additional variables that were added to the equation when the lagged advertising variables were interacted with the price term. We chose to use the simple demand shifting model instead.

Four models of Sunsweet's prune demand have been specified to represent the various permutations in diagnostic testing that were performed in the development of a preferred model:

Model 1.1:

$$QP = \beta_1 + \beta_2 SunP + \beta_3 PLP + \beta_4 SMP + \beta_5 MP + \beta_6 DMP + \beta_7 CP + \beta_8 Income + \beta_9 Trend + \beta_{10} Sum + \beta_{11} Spr + \beta_{12} Win + \beta_{13} Total\%ACVDisp + \beta_{14} Total\%ACVFeat + \beta_{15} Tota\%ACVFD + \beta_{16} SunAdv + \sum_{j=1}^{5} \beta_{16+j} SunAdv_{t-j} + \varepsilon$$

Model 2.1:

$$QP = \beta_1 + \beta_2 SunP + \beta_3 SubstP + \beta_4 Income + \beta_5 Trend + \beta_6 Sum + \beta_7 Spr + \beta_8 Win + \beta_9 Total\%ACVDisp + \beta_{10} Total\%ACVFeat + \beta_{11} Tota\%ACVFD + \beta_{12} SunAdv + \sum_{j=1}^{5} \beta_{12+j} SunAdv_{t-j} + \varepsilon$$

Model 3.1:

$$QP = \beta_1 + \beta_2 SunP + \beta_3 PLP + \beta_4 SMP + \beta_5 MP + \beta_6 DMP + \beta_7 CP + \beta_8 Income + \beta_9 Trend + \beta_{10} Sum + \beta_{11} Spr + \beta_{12} Win + \beta_{13} Total\%ACVDisp + \beta_{14} Total\%ACVFeat + \beta_{15} Tota\%ACVFD + \beta_{16} SunAdv + \beta_{17} QP1 + \varepsilon$$

Model 4.1:

$$QP = \beta_1 + \beta_2 SunP + \beta_3 PLP + \beta_4 SMP + \beta_5 MP + \beta_6 DMP + \beta_7 CP + \beta_8 Income + \beta_9 Trend + \beta_{10} Sum + \beta_{11} Spr + \beta_{12} Win + \beta_{13} Total\%ACVDisp + \beta_{14} Total\%ACVFeat + \beta_{15} Tota\%ACVFD + \beta_{16} SunAdv + \varepsilon$$

Model 1.1 includes all competitors' prices broken down by each company and has the advertising variable lagged five times. Model 2.1 uses an aggregate average retail price for all of the substitute companies and uses five lagged advertising variables. Model 3.1 has the prices broken down by each company, along with a lagged dependent variable (*QP1*), and uses just an advertising variable. Model 3.1 allows for infinite lags of the advertising variable. Model 4.1 has the prices broken down by each competitor and uses no lagged advertising variables.

For all of the models, the *ß* coefficients represent multipliers that translate into quantity changes due to one-unit changes in a specific right-hand-side variable such as price, with all other variables held constant. Again, these four models represent nearly a dozen specifications.

Each model was examined to find the preferred model. Table 4.1 lists each model with the coefficient, t-value (in parenthesis), and elasticity (in brackets) specified. The adjusted R^2 value is also reported for each model.

Table 4.1 Coefficient and Elasticity Estimates for the Weekly Demand Model

Independent Variables	(1)	(2)	(3)	(4)
Constant	-779,959	-968,436	-999,069	-1,034,974
	(-2.280)	(-3.140)	(-2.310)	(-2.430)
QP1	-	-	0.069	-
	-	-	(1.300)	-
SunP	-292,677	-297,791	-295376	-289678
	(-19.230)*	(-20.370)*	(-15.510)*	(-15.720)*
	[-2.450]	[-2.500]	[-2.480]	[-1.382]
SubstP	-	66,948	-	-
	-	(1.380)	-	-
	-	[0.470]	-	-
PLP	218,963	-	141,904	123,199
	(2.340)*	-	(1.280)	(1.120)
	[1.306]	-	[0.847]	[0.984]
SMP	-38,856	-	-154,056	-174,072
	(-0.860)	-	(-2.910)*	(-3.470)*
	[-0.330]	-	[-1.322]	[-0.980]
MP	3,646.560	-	22,869	18,254
	(0.120)	-	(0.610)	(0.490)
	[0.023]	-	[0.145]	[0.164]
DMP	900.670	-	35,351	36,385
	(0.060)	-	(1.930)	(1.990)*
	[0.006]	-	[0.239]	[0.345]
CP	26,374	-	10,976	10,498
	(1.580)	-	(0.580)	(0.560)
	[0.189]	-	[.078]	[0.098]
Income	36.820	48.016	53.204	56.854
	(3.030)*	(4.800)*	(3.480)*	(3.810)*
	[4.290]	[5.600]	[6.203]	[8.734]
Trend	-184.820	-167.062	-51.979	-86.869
	(-0.800)	(-0.870)	(-0.190)	(-0.320)

Continued.

Table 4.1 Coefficient and Elasticity Estimates for the Weekly Demand Model - Continued

Independent Variables	(1)	(2)	(3)	(4)
Sum	-12,864	-16,807	-31,535	-33,009
	(-1.770)	(-2.370)*	(-3.770)*	(-3.990)*
Spr	-764.960	-6810.153	767.711	-872.055
	(-0.100)	(-1.150)	(0.080)	(-0.090)
Win	25,382	27,266	28,612	29,215
	(4.110)*	(5.050)*	(3.730)*	(3.820)*
Total%ACVDisp	4,135.770	4,961.919	4,287.164	4,567.397
	(2.790)*	(3.830)*	(2.370)*	(2.550)*
	[0.419]	[0.502]	[0.434]	[0.654]
Total%ACVFeat	1,916.880	2,014.209	3,110.725	2,939.568
	(1.120)	(1.230)	(1.560)	(1.480)
	[0.020]	[0.021]	[0.032]	[0.089]
Total%ACVFD	-29,362.420	-3,580.961	-4,025.121	-2,228.694
	(-0.760)	(-0.910)	(-0.780)	(-0.450)
	[-0.009]	[-0.010]	[-0.006]	[-0.0003]
SunAdv	0.043	0.039	0.040	0.038
	(4.300)*	(4.220)*	(3.680)*	(3.540)*
	[0.025]	[0.023]	[0.023]	[0.081]
SunAdv1	0.042	0.039	-	-
	(4.500)*	(4.210)*	-	-
	[0.024]	[0.022]	-	-
SunAdv2	0.036	0.035	-	-
	(3.650)*	(3.650)*	-	-
	[0.022]	[0.021]	-	-
SunAdv3	0.025	0.026	-	-
	(2.520)*	(2.730)*	-	-
	[0.016]	[0.017]	-	-
SunAdv4	0.006	0.006	-	-
	(0.610)	(0.640)	-	-
	[0.004]	[0.004]	-	-
SunAdv5	0.015	0.016	-	-
	(1.640)	(1.720)	-	-
	[0.010]	[0.010]	-	-
Adjusted R^2	0.906	0.902	0.842	0.841

Note: t-statistics are in parenthesis and elasticities are in brackets. Starred numbers are statistically significant at 95% level of confidence.

Model 1.1 This model was selected as the preferred model. All other models will be compared to this model to give some insight to how this model was selected. This model has the highest adjusted R^2 of 0.906, which can be interpreted as the right hand side variables of this equation explain 90.6% of the variation of Sunsweet's total dried prune quantity. The Sunsweet price (*Sunp*) coefficient is negative and significant which suggests if Sunsweet were to increase its prices its quantity demanded would fall, consistent with the law of demand. In models 3.1 and 4.1 *SMP* shows a complementary effect, which is peculiar. All of the competitors' price elasticities, when taken as an aggregate (model 2.1) are positive suggesting as the competitors increase their prices Sunsweet's quantity demanded would increase; this suggests these products are substitutes. These results intuitively make (mostly) substitutability sense given that these are nearly identical products. However, only the private label price coefficient shows significance in model 1.1. The income coefficient is positive and significant suggesting prunes are a normal good as we would suspect; as incomes increase people would increase their consumption of prunes. The trend variable seems to be picking up some negative correlation associated with decreasing demand for prunes; however the coefficient is insignificant. There is seasonality present in all of the models; summer and spring have a negative effect on demand relative to fall. However both are insignificant, winter on the other hand has a positive correlation and is significant. This suggests that prune demand increases in the winter months relative to fall. This coincides with the Alston et al. (1998) study; however they also found spring's impacts to be significantly positive as well. The *Total%ACVDisp* coefficient is positive and significant suggesting promotional displays placed in stores do increase Sunsweet demand. *Total%ACVFeat* coefficient is positive; however is not statistically significant. The *Total%ACVFD* coefficient is negative, but is also insignificant.

All advertising coefficients are positive however lag four and five are not significant though taken jointly, an F-test revealed, joint significance. While these coefficients are positive and suggest advertising increases demand, the impacts become smaller as one goes back in time. This is consistent with understood advertising effects. Considering that Sunsweet's entire advertising budget is currently focused on their Sunsweet One's product, these coefficients being so small is not of too much concern. Since our model in this section looks at Sunsweet's total demand of dried prunes, it is good to see that this focused advertising is also increasing their total demand. We will take up this issue again when we examine the particular demand estimation for the Ones product.

The elasticity on Sunsweet's price for its prunes is -2.45 (calculated by averaging over all observations). Sunsweet is producing in the elastic region of its demand curve, consistent with a story of monopolistic competition. It is expected that Sunsweet would produce in the elastic region of its demand curve because a profit maximizing firm will never operate in the inelastic region of its demand. Further, the estimate of elasticity being far from infinite also is consistent with the hypothesis that Sunsweet is not a price-taking firm. The elasticity suggests a 1% increase in price leads to a 2.45% decrease in quantity demanded on average.

The elasticities of each advertising variable taken individually are rather small however because lagged advertising coefficients may be summed the average elasticity of all of the advertising reveals an elasticity of 0.10 indicating a 1% increase in advertising dollars increases demand by 0.10 percent per week. We note that this is consistent with that found by Alston et al. when looking at the effect of Sunsweet's advertising on the demand for all prunes at a time when Sunsweet's market share was much greater than it is today. The long-run advertising elasticity is calculated by taking a sum of all of the advertising coefficients and multiplying it by the advertising divided by the Sunsweet total quantity and then averaged over all observations. To put this in perspective, if Sunsweet were to increase its advertising expenditures by approximately 50% or $100,000 per week they can increase their weekly sales by 5 percent. This would lead to a quantity demand increase of nearly 16,000 pounds per week, which is approximately a $41,000 increase in weekly revenues if prices went unchanged. Also, the elasticities of each advertising variable decrease as you move further from each advertisement (lag1-5); which is consistent with our expectations. As you get later into the weeks after an advertisement, the effect of that advertisement should decrease.

<u>Model 2.1:</u> This model represents very similar results as Model 1.1. However with the substitute prices all combined the coefficient is positive but insignificant. Having these variables broken down by each competitor is preferred for further analysis. The summer dummy coefficient stays negative. However becomes significant in this model. From Model 1.1 to Model 2.1 these are the only changes found.

<u>Model 3.1:</u> By adding the quantity-dependent lagged variable to the right hand side of the model, one can calculate an infinitely lagged advertising model. The advertising elasticity from the infinite lag was nearly identical (0.10) to model 1.1, but model 3.1 had other problems, namely, the fact that introducing a lagged dependent variable introduces autocorrelation. Other

changes observed in the model are the Private Label Price coefficient becomes insignificant and the Sun Maid price coefficient becomes significant. Like model 2.1, the summer dummy coefficient becomes significant and the spring dummy coefficient becomes positive, but remains insignificant.

Model 4.1: By only having one advertising variable the model was not ideal. One big change was the price elasticity on the Sunsweet price dropped (in absolute value) considerably from -2.45 in Model 1.1 to -1.38 in Model 4.1. Another change is that the advertising variable only has an elasticity of 0.08 as opposed to the 0.10 that is found in Model 1.1, showing the importance of the lag variables in the model. The R^2 also drops by roughly six percentage points.

Overall, however, the four models do share roughly consistent stories about the direction of effects. Because of slight benefits we chose model 1.1 for the simulation to estimate benefits and costs of advertising.

Ones Model

With all of Sunsweet's advertising expenditures focusing on their Sunsweet One's product, we decided to estimate our model as a quantity dependent model with only the total quantities being the Sunsweet Ones as opposed to the model above which looked at Sunsweet's total dried prune quantities. All of the same variables were used except the dependent variable is now Ones weekly quantity and we have included a price for the One's product. The same analysis went into these equations as above and Ordinary Least Squares was chosen as the method used for all of the equations. Four different models have been specified to show how different variables being included and removed can alter the results. A preferred model has been selected and is equation 1.2. All other models will be compared to this model.

Model 1.2:

$$QOnes = \beta_1 + \beta_2 SunP + \beta_3 OnesP + \beta_4 PLP + \beta_5 SMP + \beta_6 MP + \beta_7 DMP + \beta_8 CP + \beta_9 Income + \beta_{10} Trend + \beta_{11} Sum + \beta_{12} Spr + \beta_{13} Win + \beta_{14} Total\%ACVDisp + \beta_{15} Total\%ACVFeat + \beta_{16} Total\%ACVFD + \beta_{17} SunAdv + \sum_{j=1}^{5} \beta_{17+j} SunAdv_{t-j} + \varepsilon$$

Model 2.2:

$$QOnes = \beta_1 + \beta_2 SunP + \beta_3 OnesP + \beta_4 SubstP + \beta_5 Income + \beta_6 Trend + \beta_7 Sum + \beta_8 Spr + \beta_9 Win + \beta_{10} Total\%ACVDisp + \beta_{11} Total\%ACVFeat + \beta_{12} Tota\%ACVFD + \beta_{13} SunAdv + \sum_{j=1}^{5} \beta_{14+j} SunAdv_{t-j} + \varepsilon$$

Model 3.2:

$$QOnes = \beta_1 + \beta_2 SunP + \beta_3 OnesP + \beta_4 PLP + \beta_5 SMP + \beta_6 MP + \beta_7 DMP + \beta_8 CP + \beta_9 Income + \beta_{10} Trend + \beta_{11} Sum + \beta_{12} Spr + \beta_{13} Win + \beta_{14} Total\%ACVDisp + \beta_{15} Total\%ACVFeat + \beta_{16} Tota\%ACVFD + \beta_{17} SunAdv + \beta_{18} QOnes1 + \varepsilon$$

Model 4.2:

$$QOnes = \beta_1 + \beta_2 SunP + \beta_3 OnesP + \beta_4 PLP + \beta_5 SMP + \beta_6 MP + \beta_7 DMP + \beta_8 CP + \beta_9 Income + \beta_{10} Trend + \beta_{11} Sum + \beta_{12} Spr + \beta_{13} Win + \beta_{14} Total\%ACVDisp + \beta_{15} Total\%ACVFeat + \beta_{16} Tota\%ACVFD + \beta_{17} SunAdv + \varepsilon$$

Model 1.2 includes all competitors' prices broken down by each company and has the advertising variable lagged five times. Model 2.2 uses an aggregate average retail price for all of the substitute companies and uses five lagged advertising variables. Model 3.2 has the prices broken down by each company, along with a lagged dependent variable, and uses just an advertising variable model 3.2 allows for infinite lags of the adverting variable. Model 4.2 has the prices broken down by each competitor and uses no lagged advertising variables. Again, these four models represent nearly a dozen specifications examined.

For all of the models, the β coefficients represent multipliers that translate into quantity changes due to one-unit changes in a specific right hand side variable such as price, with all other variables held constant.

Each model was examined to find the preferred model. Table 4.2 lists each model with the coefficient, t-value (in parenthesis), and elasticity (in brackets) specified. The adjusted R^2 value is also reported for each model.

Table 4.2 Coefficient and Elasticity Estimates from Weekly Ones Demand

Independent Variables	(1)	(2)	(3)	(4)
Constant	-98,877	-83,221	-18,617	-146,389
	(-1.880)	(-1.690)	(-0.350)	(-1.600)
QOnes1	-	-	0.683	-
	-	-	(13.46)	-
SunP	1,132.513	-561.402	-4,644.594	18,22.851
	(0.490)	(-0.240)	(-2.040)*	(0.460)
	[0.087]	[-0.044]	[-0.367]	[0.144]
OnesP	-18,037	-22,157	-12,514	-26,686
	(-4.630)*	(-5.830)*	(-3.370)*	(-4.210)*
	[-1.983]	[-2.436]	[-1.376]	[-2.934]
SubstP	-	7,100.331	-	-
	-	(0.910)	-	-
	-	[0.474]	-	-
PLP	17,945	-	1,468.590	-9,712.775
	(1.260)	-	(0.110)	(-0.410)
	[1.024]	-	[0.084]	[-0.554]
SMP	-11,886	-	134.597	-44,293
	(-1.740)	-	(0.020)	(-4.090)*
	[-0.980]	-	[0.011]	[-3.650]
MP	-1,430.649	-	4,191.845	1,606.720
	(-0.320)	-	(0.940)	(0.200)
	[-0.087]	-	[0.254]	[0.097]
DMP	-376.626	-	3,724.535	10,359
	(-0.150)	-	(1.590)	(2.550)*
	[-0.024]	-	[0.242]	[0.672]
CP	7,681.105	-	1,558.929	2,646.430
	(2.920)*	-	(0.680)	(0.650)
	[0.527]	-	[0.107]	[0.181]
Income	4.066	4.019	1.409	9.570
	(2.190)*	(2.510)*	(0.740)	(2.990)*
	[4.543]	[4.490]	[1.575]	[10.693]
Trend	34.319	22.926	23.223	64.562
	(0.970)	(0.730)	(0.690)	(1.090)
Sum	-346.922	-1,342.466	-1,608.817	-6,509.127
	(-0.300)	(-1.150)	(-1.440)	(-3.460)*
Spr	610.632	1,120.013	76.537	763.648
	(0.540)	(1.190)	(0.070)	(0.380)

Continued.

Table 4.2 Coefficient and Elasticity Estimates from Weekly Ones Demand-Continued

Independent Variables	(1)	(2)	(3)	(4)
Win	4,621.459	5,976.030	2,709.100	6,027.732
	(4.770)*	(6.850)*	(2.820)*	(3.650)*
Total%ACVDisp	736.538	908.940	293.100	845.801
	(3.260)*	(4.300)*	(1.330)	(2.200)*
	[0.692]	[0.853]	[0.275]	[0.794]
Total%ACVFeat	196.951	93.683	199.721	451.133
	(0.750)	(0.360)	(0.830)	(1.060)
	[0.019]	[0.009]	[0.019]	[0.043]
Total%ACVFD	-123.989	-280.607	-484.824	-146.969
	(-0.210)	(-0.450)	(-0.810)	(-0.140)
	[-0.003]	[-0.007]	[-0.012]	[-0.004]
SunAdv	0.011	0.010	0.013	0.010
	(6.870)*	(6.350)*	(9.850)*	(4.150)*
	[0.050]	[0.043]	[0.060]	[0.044]
SunAdv1	0.012	0.012	-	-
	(8.580)*	(7.980)*	-	-
	[0.053]	[0.051]	-	-
SunAdv2	0.010	0.010	-	-
	(6.340)*	(6.340)*	-	-
	[0.044]	[0.044]	-	-
SunAdv3	0.005	0.006	-	-
	(3.330)*	(3.930)*	-	-
	[0.025]	[0.029]	-	-
SunAdv4	0.003	0.003	-	-
	(1.930)	(2.020)*	-	-
	[0.014]	[0.016]	-	-
SunAdv5	0.004	0.005	-	-
	(2.360)*	(3.370)*	-	-
	[.018]	[0.026]	-	-
Adjusted R^2	0.944	0.936	0.947	0.834

Note: t-statistics are in parenthesis and elasticities are in brackets. Starred are statistically significant at a 95% confidence level.

Model 1.2: Model 1.2 was selected as the preferred model; however there were many models that were a good fit for this data. In reality model 2.2 and model 3.2 could have been selected and we would have gotten similar results and interpretations. All other models presented here will be compared to Model 1.2. This model had one of the highest adjusted R^2 of 0.944, which can be interpreted as the right hand side variables of the model explain 94.4% of the variation of Sunsweet One's quantity. The Ones Price coefficient (*OnesP*) is negative and significant, which suggest if Sunsweet were to increase its price of One's its quantity demanded of One's would decrease which is what we would expect. Sunsweet's overall dried prune price is positive which suggests an increase in Sunweet's total prices would cause an increase in the quantity of One's being demanded suggesting that the One's are substitutes to other Sunsweet dried prune products. Three of the competitors' price coefficients were negative suggesting that they are complements to Sunsweet Ones, which is not what is expected. However these all come in as insignificant. Two of the substitutes did enter into the model in positive manner, which indicates they are substitutes. There may have been some variation in these results due to this model looking at a specific Sunsweet product and using overall data for all competitors. The income coefficient is positive and significant suggesting Ones are normal goods as we would expect; as peoples' incomes increase their consumption of prunes increases. The trend coefficient was included to account for negative correlation associated with decreasing demand for prunes; however this coefficient was consistently positive in all of the Ones models and insignificant to the study. There is definite seasonality in the model, the summer dummy coefficient is negative suggesting people eat fewer prunes in the summer months; however it is insignificant. Spring is positive but insignificant; however winter is positive and significant suggesting that people eat more prunes in the winter months, as was found in the previous demand model of total prune consumption. The *Total%ACVDisp* coefficient is positive and significant suggesting displays placed in stores do increase Sunsweet demand. *Total%ACVFeat* coefficient is positive; however is not statistically significant. Surprisingly the *Total%ACVFD* coefficient is negative, but is also insignificant. All of the advertising coefficients are positive and significant showing that the advertising for the Sunsweet One's is increasing their overall demand. Another important trend in these variables is that they continually decrease as they get further out in the lag. This intuitively makes sense as the time since the advertising increases, the effect on demand decreases.

The important elasticities to discuss from this model are the Ones Price Elasticity and the overall advertising elasticity. The average elasticity of Ones Price is -1.983, which suggests Sunsweet is producing in the elastic region of its demand curve, consistent with a story of monopolistic competition. This indicates a 1% increase in price leads to a 1.98 decrease in quantity demanded. Importantly, producing in the elastic region but less elastic than in the *QP* model indicated *QOnes* demand curve is steeper than the *QP* demand curve, which is consistent with a story of Sunweet creating a differentiated product with its Ones brand. The individual elasticities from each advertising coefficient are rather small; however the long-run advertising elasticity is 0.2399. This is calculated by taking a sum of all of the advertising coefficients and multiplying it by the advertising value divided by the Ones mean quantity and then averaging over all observations. This elasticity is showing a 1% increase in advertising dollars would increase demand by 0.24 percent per week. To put this into perspective, if Sunsweet were to increase their advertising expenditures by approximately 50% or $100,000 per week they can increase their sales by 12% per week. This would lead to a quantity demand increase of nearly 4,400 pounds per week of Ones, which is approximately a $15,500 increase in revenues per week. Notice that the model is less elastic than the overall demand model, which would be expected given that we have a differentiated product. Also, advertising has the biggest effect in these models because the ones are what the advertising is geared towards.

Model 2.2: Model 2.2 is very similar to Model 1.2. In this model the Sunsweet price coefficient is negative suggesting Sunsweet's other products are complements to Ones. This alternative can also be the case; however both coefficients in Model 1.2 and 2.2 were insignificant. With the substitutes all grouped together the coefficient is positive supporting that all of the competitors used in the model are substitutes. The Ones Price Elasticity in the model is significantly higher (in absolute value) at -2.436. The advertising elasticity is the same at 0.24.

Model 3.2: Model 3.2 included a lagged dependent variable, *QOnes1* added to the right hand side of the model to calculate infinitely lagged advertising models. The advertising elasticities from the infinite lag was nearly identical to model 1.2, but model 3.2 had inconsistencies including the fact that introducing a lagged dependent variable introduces autocorrelation. This variable was added to determine the validity of using lagged advertising variables. Other differences found was the Sunsweet Price coefficient was reported as a negative as in model 2.2; however this time it was significant. All competitor price coefficients were positive and insignificant.

Model 4.2: This model had all of the variables of model 1.2 except the lagged advertising variables were not included. Differences observed when compared to model 1.2 included that only one of the coefficients on competitor prices was negative and the rest positive. The coefficient on the summer dummy variable remained negative, but became significant. The advertising elasticity was a small 0.04 without the lag variables; once again showing the importance of the lagged advertising variable. The price elasticity for ones also increased (in absolute value) in this model to -2.934.

It is clear that almost all of these models are telling the same story. It is good to see that the results were consistent from model to model and we were able to find many models that were a good fit to the data because a well-fitting conceptual model will be important to the simulation that follows.

Chapter 5 - Estimating the Benefits of Advertising

The firm demand curve for a company with a differentiated product is a function of each separate competitors' supply curves. This varies from an undifferentiated product demand curve in that the curve only relies on a combination of the supply curves of each competitor. The inverse demand curve (average revenue) for a differentiated product is as follows:

$$p_i = D(q_1,.....q_n)$$

With p_i being the price that firm *i* can charge depending on the quantity of all other brands (n-1). Or written as a function of prices of each competitor, which is how the Sunsweet demand curve is expressed in this research.

$$q_i = D(p_1, p_2,.....p_n)$$

From an estimation from Sunsweet, we adjusted the quantity demanded in the simulation that follows to reflect 100% of Sunsweet U.S. retail sales. Thus, our simulation is for the entire U.S. market, not for the 86% of demand represented by the data.

The analysis in the section will look at the data from Sunsweet to see if they are operating where their average revenue curve is greater than their average cost curve in the short run. The more differentiated the product, the less a firm's demand is reliant on its competitors' actions, which in turn leads to a downward sloping demand curve. We use the standard notation that when our demand curve, $Q(P)$, is written in its inverted form (i.e. as a function of quantity, $P(Q)$), we refer to it as the average revenue (AR) function. This average revenue function is simply a representation of our regression analysis demand equation with *c* representing all other variables in the model and the *bQ* representing the price variable in the model. A mathematical representation of the Sunsweet model that we adopt for the simulation is as follows:

$$Q = Sunsweet \;\; Sales = c - bp$$
$$P(Q) = AR \;\; Function(demand) = c - bQ$$
$$C(Q) = Cost = a + MC * Q + Adv$$
$$\pi = P(Q) * Q - C(Q) \qquad (1)$$
$$FOC : MR - MC = 0$$
$$P(Q) + P'(Q) * Q - C'(Q) = 0$$
$$Note : C'(Q) = MC$$
$$P(Q) + P'(Q) * Q = MC \qquad (2)$$

In order to measure the welfare impact of advertising by Sunsweet four main components need to be developed (1) a model of Sunsweet's market equilibrium (2) estimates of average cost and demand (AR) parameters (3) estimates of the average revenue (demand) response by consumers due to advertising expenditures and (4) development of measures of the shift in our average revenue (demand) and our average cost curve in order to measure our benefits and costs to Sunsweet. The average cost equation (*AC*) we chose to use was presented by Joan Robinson (1948), as a useful proxy for a short run average cost curve. This same formula was again used by Dixit and Stiglitz in 1977. This average cost curve formula using the notation from above is as follows:

$$AC = \frac{a}{q} + MC + \frac{Adv}{Q}$$

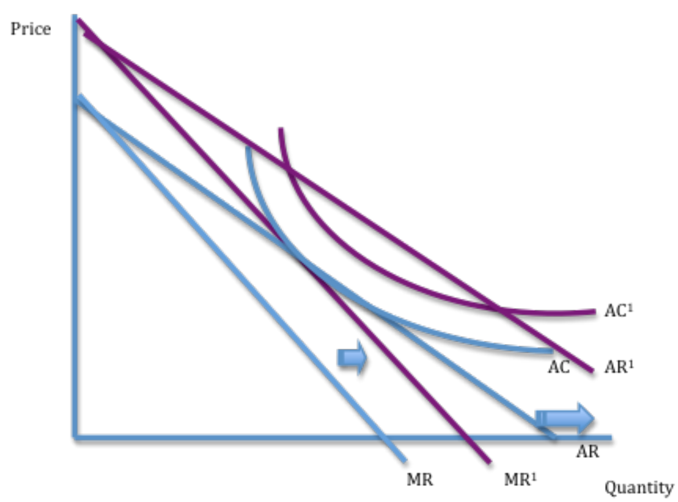
Our advertising (*Adv*) and quantity (*Q*) variables were given to us on a weekly basis from Sunsweets Infoscan IRI data. The two unknown variables in the equation are marginal cost (*MC*) and fixed costs (*a*). The variable '*c*' is determined from the regression models and '*b*' the inverted price coefficient from those models. Code was developed in the statistical program SAS to determine our marginal and average cost curve by calibrating the regression models to our asserted theory of monopolistic competition. Such calibration is consistent with the calibration of estimated industry demand to a theoretical industry supply under perfect competition as used in Alston et al. (1998). In this present model, the simulation was developed to have the average cost and marginal cost vary from observation to observation. The first set of mathematical derivations were set to find the predicted marginal cost and then went on to find the predicted average cost.

This benefit-cost analysis looks at two different scenarios in order to measure the benefits and costs associated with advertising. One scenario consists of Sunsweet's quantities and prices when advertising is being conducted (reality) and the other looks at Sunsweet's quantities and prices if advertising had not been conducted (counterfactual). The variables that we have been provided with and that we estimated in our regression models are for Sunsweet with advertising being conducted. We then use these same variables and estimates to develop a model with no advertising being conducted.

From our previous regression analysis we have been able to develop a measure that tells us how much the quantities sold of prunes would be affected by increased advertising expenditures by Sunsweet. However this does not tell us how our overall sales will be affected since we cannot assume that prices will remain unchanged if there is no advertising. So, we need to combine our demand shifts with cost shifts in order to accurately measure the benefits and costs of advertising.

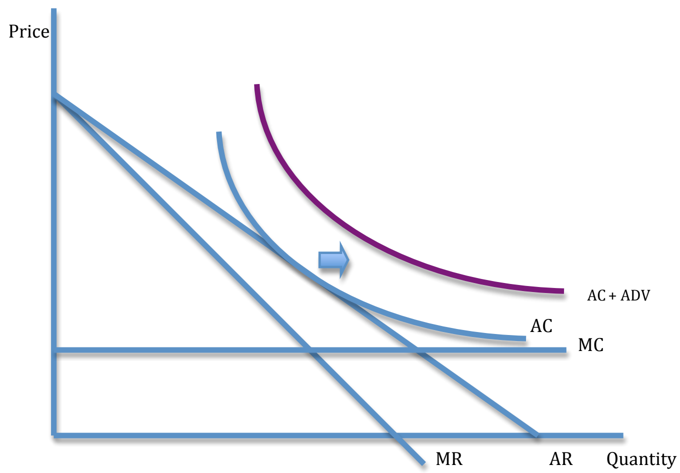
First focusing on the demand shift, our average revenue curve is our inverted demand curve for Sunsweet's prunes. Recall from the discussion in chapter 2 regarding monopolistic competition, figure 5.1 displays the supply and demand model represented by the Sunsweet data. The average revenue curves represent the demand for Sunsweet dried prunes and the average cost curve represents our average costs for Sunsweet dried prunes. An increase in advertising causes a shift in our average revenue curve to AR^1.

Figure 5.1 Demand Shift



Many products become differentiated through branding and advertising, much like Sunsweet has done with its Ones products. The shift in Sunsweet's average cost curve is equal to the advertising expenditures divided by quantity. Figure 5.2 represents only the shift in the average cost curve associated with increased advertising expenditures. This is the cost portion of our benefit cost ratio. Increased demand from the advertising also causes a shift in the average revenue curve, which also causes a shift in the marginal revenue curve. If the average cost curve shift is less than the average revenue curve shift as drawn above, the result is a benefit-cost ratio that is greater than one. This profit making opportunity only occurs in the short run before the average revenue curve is shifted to the left caused by new competitors entering the market or other competitors influencing their own demands until the average cost curve for each firm is tangent to its average revenue curve as shown in the blue curves of figure 5.1.

Figure 5.2 Average Cost Shift



In order to develop a benefit-cost analysis we used the regression results to develop our average revenue curve and determine our average cost curve. From these results we developed a model that represents the average revenue, marginal revenue, marginal cost, and average cost curves with and without advertising.

The first variable to find was marginal cost (MC), which we assume is invariant to quantity in the short run (Robinson 1948). We used a five step mathematical process to find our marginal cost curve and our average cost curve without advertising. The first step was to use the average revenue curve (AR^1) that we found in our regression results to find our marginal revenue (MR^1) by simply taking the derivative of our total revenue curve (TR^1). The second step was to assume profit maximization was occurring and so set MR^1=MC to find MC. Next, to find MR with no advertising we set advertising equal to zero in our MR^1 equation to get MR^0 (marginal revenue without advertising). The fourth step was to set our MR^0=MC to find the quantity that would have occurred without advertising (Q^0). In the final step we used the Q^0 from step four to find our price without advertising from our average revenue curve without advertising. This is expressed in the flow chart in figure 5.5. From these derivations we have determined our MC, our P^0 and Q^0 associated with Sunsweet not doing any advertising. These steps are repeated for all observations.

Figure 5.3 Flow Chart of Mathematical Derivations

$$
\begin{aligned}
&\textit{Step } 1:\\
&TR^1 = cQ - bQ^2\\
&AR^1 = \frac{TR}{Q} = c - bQ\\
&MR^1 = \frac{\partial TR}{\partial Q} = c - 2bQ\\
&\textit{Step } 2:\\
&\textit{Assume Profit Maximizing}\\
&\textit{So, } MR^1 = MC\\
&\textit{Step } 3:\\
&\textit{Find } MR^0 \textit{ without advertising}\\
&\textit{Set Advertising} = 0 \textit{ in } AR^1\\
&\textit{Step } 4:\\
&\textit{Set } MR^0 = MC \textit{ to find } Q^0\\
&\textit{Step } 5: \textit{ Find } P^0 \textit{ from } Q^0 \textit{ using } AR^0
\end{aligned}
$$

The next step was to find our average cost curve by starting with our cost function and finding our average cost function. We will present the mathematical steps done here and then explain what we have done below. We know the *Adv* is a fixed cost for Sunsweet and treat it as such in the model.

Figure 5.4 Average Cost Derivation

$$
\begin{aligned}
&Step\ \ 1: \\
&C = a + MCQ + Adv \\
&AC = \frac{a}{Q} + MC + \frac{Adv}{Q} \\
&When\ \ Adv = 0\ \ we\ \ assume\ \ AC = P \\
&Then\ \ find\ a\ (other\ \ fixed \cos ts)\ \ by\ \ solving\ \ for\ a \\
&AC^{0} = P^{0} = \frac{a}{Q^{0}} + MC \\
&Step\ \ 2: \\
&Find\ \ AC^{1}\ \ when\ \ Adv > 0 \\
&AC^{1} = \frac{a}{Q^{1}} + MC + \frac{Adv}{Q^{1}}
\end{aligned}
$$

In step one we are using the average cost curve presented by Robinson (1948) and used by Dixit and Stiglitz (1977), setting our advertising equal to zero and assuming our average cost is equal to our price found above and solving this to get our other fixed cost variable.[1] The assumption is that if Sunsweet never advertised then it would be operating as a monopolistically competitive firm in the long run, hence, price would equal average cost. The advertising is only undertaken if it is profitable to do, so we use the fact that Sunsweet advertised as an indication the advertising must have moved Sunsweet out of its long-run equilibrium for at least a short time. We know that $a > 0$ ensures that our *AC* curve is downward sloping and concave, which is what theory dictates. Note this fixed cost will not vary with advertising and is the parameter that calibrates the model to what is actually seen in the data while representing other fixed costs. Step two is simply adding the advertising numbers in to find the average cost curve with advertising.

Then in the final step, we compare the average cost curve with advertising to our average revenue curve with advertising by using a ratio to see if it is either equal, less than, or greater than one. Note we are not setting our AC equal to our P for the model with advertising imposed, allowing for the possibility that AC is not tangent with the AR curve. Once all of these variables

---

[1] Proof that the average cost curve is tangent to the average revenue curve when MR=MC and P=AC, is outlined in appendix A.

and parameters have been determined we can find our benefits and costs that occur due to our advertising. Benefits are calculated by subtracting total revenue without advertising from total revenue with advertising (benefit = P^1Q^1-P^0Q^0). In this way we only count the revenue increase attributable to advertising alone. The cost can be determined by subtracting total costs hence, in this way we are only counting the costs of advertising alone. The cost increase is thus total cost under advertising less total cost without advertising (Cost=TC^1 - TC^0 = AC^1Q^1 - AC^0Q^0). A company would like to have a benefit/cost ratio greater than one implying that its advertising, in this case, is in fact benefiting the firm more than it is costing the firm, but there is no reason to expect benefit/cost to be >1 for every week in the data set. Essentially, we want to know whether on average Sunsweet benefited from its advertising. The two graphs in figure 5.5 show the advertising and no advertising situations.

We estimated the benefit/cost relation for both the total dried prune quantity model and the Qnes quantity model. We conducted two variations of each model one with a shutdown method and the other without a shutdown method. The shutdown method was a constraint command that we included in our program to take instances where our average cost is more than our price and reset the average cost to equal our price. The model without this constraint allowed for our average cost to be greater than our price and, hence, allowed negative economic profits. Under economic theory, no firm should operate in the long-run making negative economic profit. Given the uncertainties in the various assumptions used in the simulation, this constraint can be thought of as a "common sense constraint" on the model. The average results of all four models are presented in table 5.1 below.

Table 5.1 Average Benefit-Cost Ratios

Model	*QP*	*Qones*
With Shutdown Constraint	2.143	2.672
Without Shutdown Constraint	1.845	2.358

N=95

The benefit cost ratios above can be interpreted as follows. For every dollar of advertising spent Sunsweet is getting a $2.14 increase in revenues on average. It is apparent that the ratios for the Ones model are considerably higher than for the overall model. This is what was expected given that Sunsweet spends all of its advertising budget for prunes on the Ones product. For a firm operating under monopolistic competition these benefit-cost ratios show good returns on its advertising expenditures. These numbers may seem low when compared to other products, however under an assumption of an industry in monopolistic competition these numbers are quite good. One must consider substitutability from having other competitors in the market. To put more of a perspective on these numbers presented below in table 5.2 is the confidence interval of each benefit-cost ratio for all four different models. Notice that the 5% to 25% range is 1 when the shut down condition is implemented, this is due to our shut down condition holding the value of our average costs equal to our average revenue on certain observations; therefore resulting in a one-to-one ratio.

Table 5.2 Confidence Intervals of Benefit-Cost Ratios

	Model			
% Confidence Interval	QP W/Shutdown	QP W/O Shutdown	QOnes W/Shutdown	QOnes W/O Shutdown
5%	1.000	0.086	1.000	0.133
10%	1.000	0.109	1.000	0.165
25%	1.000	0.154	1.000	0.216
50%	2.390	2.288	2.288	2.390
75%	2.667	3.573	3.573	2.667
90%	3.376	5.311	5.311	3.376
95%	4.188	6.159	6.159	4.188
Average	2.143	1.845	2.672	2.358

Although the Alston et al. (1998) study examined the benefits and costs for the California Dried Plum Board's generic promotion, it is interesting to compare our results to theirs. When comparing our results to the Alston et al. (1998) study we had consistent findings. Alston et al. (1998) conducted two different variations of analysis to determine benefit-cost ratios for the dried prune *industry* from 1992-1996. The first analysis used an economic model to find the benefit-cost ratios for generic prune promotions and these ranged from an average of 1.86 to 4.62 for their top three preferred models. They also used another form of analysis similar to the way we developed our ratios, but using a simulation model for different supply elasticities ranging from 0 to 5 and in a perfectly competitive market (not monopolistic competition) and using OLS regression models as used in this study. Their benefit-cost ratios for their top three preferred models range from 0.22 to 3.82. Both of these different ranges are very similar to our findings. Even though the previous researchers examined industry level data we have to consider that when the Alston et al. (1998) study was conducted Sunsweet held approximately 70% of the market share (today it is only half). With this large amount of market share Sunsweet played a big role in the results of that earlier study, which can explain why our Sunsweet firm level data is so similar to this industry level data.

Chapter 6 - Dorfman-Steiner Condition

Another form of analysis we undertook was a simple application of the Dorfman-Steiner Condition. This condition states that: "the monopolist's optimal advertising/sales ratio is equal to the ratio of the elasticities of demand with respect to advertising and price," (Tirole 1988). We derived the Dorfman-Steiner Condition for each of our four benefit-cost models, along with the actual advertising-to-sales ratio that Sunsweet currently exhibits based on their actual demand. The equation for the Dorfman-Steiner (Dorfman and Steiner 1954) condition presented is as follows:

$$\textit{Dorfman}-\textit{Steiner Condition}$$
$$\frac{\textit{Advertising Budget}}{\textit{Total Revenue}} = \frac{\varepsilon_A}{|\varepsilon_P|}$$

Dorman and Steiner developed this model by assuming the demand facing a firm is a function of price and advertising ($P(q,s)$), where s represents advertising expenditures. Looking at a monopolist their profit is:

$$\pi(q,s) = qP(q,s) - C(q) - s$$
$$Where:$$
$$C(q) = P(q,s) + qP_q(q,s)$$
$$qP_s(q,s) = q$$
$$Max\ \ \pi$$
$$Let:\ \ q = D(p,s)$$
$$\pi(p,s) = pD(p,s) - C(D(p,s)) - s$$
$$FOC:$$
$$\frac{\partial \pi}{\partial p} = D(p,s) + PD_p(p,s) - C'(D(p,s))D_p(p,s) = 0$$
$$\frac{\partial \pi}{\partial s} = pD_s(p,s) - C'(D(p,s))D_s(p,s) - 1 = 0$$
$$Let:$$
$$\varepsilon_p = -\frac{\partial D}{\partial p}\frac{p}{q}$$
$$\varepsilon_s = -\frac{\partial D}{\partial s}\frac{s}{q}$$
$$AS = \frac{s}{pq} = \frac{\varepsilon_s}{\varepsilon_p}$$

Table 6.1 below shows our results for the Dorfman-Steiner condition based on our regression elasticities (DS) along with Sunsweet's current advertising to sales ratios (AS).

Table 6.1 Estimated Dorfman-Steiner Condition and Sunsweet's Actual Average Advertising-to-Sales Ratios

Model	DS	AS
QP	0.046	0.197
QOnes	0.143	0.755

Based on the Dorfman-Steiner condition Sunsweet's advertising-to-sales ratio should be around 4.6% for their overall dried prune sales and the actual is 19.7%. For the Ones product the Dorfman-Steiner value is 14.3% and their actual is considerably higher at 75.5%. When comparing the actual advertising-to-sales ratios of Sunsweet to other firms, their ratio is much higher than the norm. A table listing different advertising to sales ratios of different firms was found in a class handbook "Economic Analysis in Food Marketing" by Crespi and duplicated in table 6.2. Based on the cross comparison and the Dorfman-Steiner condition Sunsweet is evidently placing a greater emphasis on advertising at this time. The high AS ratio is indicative of a firm positioning a new product, as is the case here at a 75%. However, such a high AS ratio is likely unsustainable. Nevertheless these "back of the envelope" results coupled with the benefit-cost analysis shows a firm operating in a very competitive industry and finding itself able to make profitable advertising ventures.

Table 6.2 Popular Food Brands and their Advertising to Sales Ratios in 2007

Brand/Parent Company	Sales ($ Millions)	Advertising Promotion ($ millions)	A/S (%)
READY-TO-EAT CEREAL			
Cheerios/ General Mills	298	43	15%
Honey Bunches-Oats/ Kraft	291	37	13%
Honey Nut Cheerios/General Mills	269	50	19%
Frosted Flakes/ Kellogg	241	13	5%
CRACKERS			
Cheez-It/Kellogg	380	23	6%
Ritz/Kraft	379	29	8%
P.F. Goldfish/Campbell	324	15	5%
Wheat Thins/Kraft	324	11	3%
Triscuit/Kraft	236	16	7%
REFRIGERATED YOGURT			
Yoplait/General Mills	382	29	8%
Yoplait Light/General Mills	318	67	21%

Chapter 7 - Conclusion

This analysis looked at the effectiveness of advertising and promotion conducted by Sunsweet. Based on the economic theory of consumer demand, models were developed to determine the quantity demanded on a weekly basis of both Sunsweet prunes and the Sunsweet Ones product as a function of prune prices, advertising expenditures, and other relevant variables. From these demand models, two different types of analysis were performed: a benefit-cost analysis and a Dorfman-Steiner analysis.

From our demand analysis we were able to conclude that advertising does have a positive impact on Sunsweet's prune demand. Using ordinary least squares regressions, the elasticity of prune demand with respect to Sunsweet advertising for the preferred model was 0.10, indicating that a 1% increase in advertising expenditures increases demand by 0.10 percent per week. The elasticity of prune demand for the Sunsweet Ones product with respect to Sunsweet advertising for the preferred model was 0.24, indicating that a 1% increase in advertising expenditures increases demand by 0.24 percent per week.

A benefit-cost analysis was conducted under an assumed hypothesis of monopolistic competition. The total Sunsweet dried prune model resulted in an average benefit cost ratio of 2.142 and 1.845, depending on assumption of profitable shut-down conditions as discussed in the chapter. These ratios show good returns on advertising for Sunsweet. The Ones model resulted in higher benefit-cost ratios of 2.672 with a shutdown assumption and 2.358 without the assumption. It would be expected that these would be higher given that all of Sunsweet's advertising is currently focused on the Ones product. Overall, these are good benefit-cost ratios, they are getting a good amount of return from their advertising expenditures.

The Dorfman-Steiner condition uses a ratio of the elasticities of advertising and price to determine the optimal advertising to sales ratio a firm should be operating at. The Dorfman-Steiner ratio for Sunsweet's total prune model came out to be 4.6% when their actual is 19.7%. The Dorfman-Steiner ratio for the Sunsweet Ones product came out to be 14.3% when their actual is 75.5%. Overall, from this condition Sunsweet might reduce its advertising expenditures overall in order to be closer to their optimal allocation for advertising. Also from comparisons of other firms advertising-to-sales ratios Sunsweet's are considerably higher than most.

We concluded that Sunsweet's advertising has increased its overall demand along with its Ones product demand. We also found that its benefits are exceeding its costs with benefit-cost ratios ranging from 1.845 to 2.672. However, Sunsweet's current expenditures may not be optimal over the long run according to the Dorfman-Steiner condition and like comparisons.

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Appendix A - Proof

Proof that AC curve is tangent to AR curve

$$\text{Proof}:\ \frac{dp}{dQ} = \frac{dAC}{dQ} \quad when \quad MR = MC \ \& \ P = AC$$

$$1 - Q = c - bp$$

$$2 - P = \frac{c}{b} - \frac{1}{b}Q$$

$$3 - AC = \frac{a}{Q} + MC$$

$$4 - MR = \frac{c}{b} - \frac{2}{b}Q = MC \quad (\text{Proof} \quad Max \ \ Cond)$$

$$I.\ From \ \ 2:\ \frac{dp}{dQ} = -\frac{1}{b}$$

$$II.\ From \ \ 3:\ \frac{dAC}{dQ} = -\frac{a}{Q^2}$$

$$When \ \ P = AC,\ we \ \ have$$

$$P = \frac{a}{Q} + MC$$

$$\Rightarrow \quad a = (P - MC)Q$$

$$Therefore:$$

$$\frac{dAC}{dQ} = -\frac{(P - MC)Q}{Q^2} = -\frac{(P - MC)}{Q}$$

$$Substitute \ \ MC \ \ from\ 4 \ \ and \ \ P \ \ from\ 2:$$

$$\frac{dAC}{dQ} = -\frac{\left(\frac{c}{b} - \frac{1}{b}Q - \frac{c}{b} + \frac{2}{b}Q\right)}{Q} = -\frac{\left(\frac{1}{b}Q\right)}{Q}$$

$$\frac{dAC}{dQ} = -\frac{1}{b} \quad Which \ \ is \ \ the \ \ same \ \ as \ \ I$$

$$QED$$