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Measuring the Benefits to Advertising under Monopolistic Competition

Michael A. Boland, John M. Crespi, Jena Silva, and Tian Xia

This paper determines the benefits and costs of firm-level advertising in a monopolistically competitive industry. The model is useful in an environment in which firm-level costs may be absent or imprecise. The empirical example uses data on the advertising for a new line of prune snacks by Sunsweet Growers between 2008 and 2010, revealing average benefit-cost estimates from \$1.26 to \$4.35 for every dollar allocated to the new product line.

Key words: advertising, benefit-cost analysis, industrial organization, monopolistic competition, agricultural marketing

Introduction

Nearly all published studies measuring the benefits and costs of advertising in agricultural markets focus on the specific type of advertising known as generic advertising, which is financed by industry producers. There are nearly 250 published studies—including 124 peer-reviewed journal articles and chapters in 14 books—examining the effectiveness of collective commodity promotion programs.¹ The overwhelming majority of these studies have shown that benefits outweigh costs, many of which are summarized in Alston et al. (2007). However, there is little research measuring the impact of advertising for a specific food product. Food products are increasingly heterogeneous as firms are able to create and market successful brands. Furthermore, as these firms turn to new branded product development and increased brand-level advertising to defend market share, many of these industries arguably resemble monopolistically competitive industries, for which no empirical measure of advertising return has been reported in the agricultural economics literature. The objective of this research is to estimate an average benefit-cost ratio for a firm operating in a monopolistically competitive industry. The food product we use is a differentiated prune marketed by Sunsweet Growers.

Monopolistic Competition

The theoretical work on monopolistic competition was initially done by Chamberlin (1933) and Robinson (1933). Monopolistically competitive industries are typified by multiple distinct firms selling branded products that are slightly differentiated; as such, prices typically differ among competing brands. These markets differ from traditional oligopoly structures in that barriers to entry

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¹ This is based on a search using the academic search engine EconLit on the key words “generic/commodity and advertising/promotion.”

are lower—but not absent—with economic profits diminishing as new entrants enter the market with slightly differentiated brands of their own. Brand advertising contributes to fixed costs in the short run because a firm must often set its advertising budget far in advance of sales. Under monopolistic competition, economic profit is short-lived as new firms enter the market and profits dissipate. The difference between this equilibrium and that of perfect competition is that with free entry but differentiated products, firms under monopolistic competition price at an average cost that is above marginal cost (e.g., Carlton and Perloff, 2005, pp. 206–208).

Because barriers to entry are lower under monopolistic competition than under oligopoly or monopoly, firms can earn short-run economic profit by creating and marketing new products and reaping the short-term benefits of a price above both marginal and average cost, at least until rivals create their own slightly different versions of that product or new firms enter the market. Our interest is in calculating the benefit-to-cost ratio for such short-run profit through new product development and advertising.

Methods of Estimating Average Benefit-Cost Ratios

There are multiple ways to estimate the benefits and costs of generic advertising, product promotion, or product development.² One of the most widely-used techniques is econometric estimation of a demand curve as a function of prices, generic advertising, and other variables. With the econometric model of “reality” in hand, researchers can determine the counterfactual shift in the demand curve that would have occurred over the sample period had advertising been absent. Benefit-cost analyses then measure the changes in profit associated with advertising.

For generic advertising under perfect competition, the counterfactual (no advertising) shift in the demand curve provides only limited information because a supply curve is needed to discern the equilibrium. Alston et al. (2007) note that the modeling technique most commonly used simulates aggregate industry surplus changes with and without the advertising expenditures by interacting the estimated demand curve and a simulated industry supply curve. By calibrating a supply function to the price-quantity equilibrium, researchers then estimate the cost to the producers from the advertising and measure this against the demand shift with and without advertising.

Estimating the Benefits of Advertising under Monopolistic Competition

The greater the level of differentiation in a monopolistically competitive industry, the less a firm’s demand responds to its competitors’ actions. As such, firm demand curves are downward sloping. Price-dependent demand is given by $P(Q, A)$, where Q is the quantity. Function A relates how the firm’s advertising expenditures, ADV , are translated into the shift in the demand curve, where $A = f(ADV)$ with $f'(ADV) > 0$ for $ADV > 0$ and $f(0) = 0$. To measure the benefits of firm-level advertising under monopolistic competition, three main components need to be developed: (1) average cost and demand parameters, (2) consumer demand response from advertising, and (3) measures of the shift in the demand and the average cost curves.

Measuring Average Cost and Demand Parameters

Without a direct measure of firm costs, we adopt two potential cost functions. Costs under monopolistic competition are presumed to be fixed; a component of that fixed cost is expected to come in the form of marketing expenditures. Our first functional form is based on Robinson’s 1933 proxy for firm costs under monopolistic competition:

$$(1) \quad C(Q, ADV) = a + cQ + ADV,$$

² In keeping with the literature, we use advertising throughout the rest of the paper to include promotion and product development.

where marginal cost is per-unit and fixed costs are divided into the cost of the advertising expenditure, ADV , and other fixed costs, a . The second functional form allows marginal cost to increase with Q :

$$(2) \quad C(Q, ADV) = a + gQ^2 + ADV,$$

where $MC = 2gQ$ and $g > 0$. These two forms were chosen because they represent a wide range of solutions under profit maximization. Variants of these standard forms have been used in describing firms under monopolistic competition (e.g., Dixit and Stiglitz, 1977; Carlton and Perloff, 2005, pp. 207-210). A firm's average cost functions under these two formulations are $C(Q, ADV)/Q$ or:

$$(3) \quad AC = \frac{a}{Q} + c + \frac{ADV}{Q}$$

under constant marginal cost and

$$(4) \quad AC = \frac{a}{Q} + gQ + \frac{ADV}{Q}$$

under increasing marginal cost.³ To explain the steps for calculating the benefit-cost ratio, we use figure 1, which uses a simple linear demand function and constant marginal cost.

Consider a firm in a monopolistically competitive industry as seen in figure 1. The tangency of demand (D^0) and average cost (AC^0) is shown for the equilibrium (Q^0, P^0). If the firm is able to undertake a successful, demand-enhancing, short-run advertising of its product, demand shifts to D^1 , bringing with it a new price-quantity combination (Q^1, P^1) at the point where the new marginal revenue (MR^1) is equal to MC . New advertising expenditures also increase costs. If the outward shift in the average cost from AC^0 to AC^1 from the advertising expense results in average cost below D^1 , then the benefits of advertising outweigh the costs of advertising. Specifically, these per-unit benefits are the difference between the new price, P^1 , and the new average cost, AC^1 . Under monopolistic competition, these profits exist only in the short run until new firms enter the market or existing firms exploit their own advertising changes; the new equilibrium occurs at a tangency with a reduced demand for the firm. A firm operating under monopolistic competition will only advertise if it can effectively shift its demand curve by more than its average cost curve. Our goal is to measure the impact of such a shift.

Estimating Demand Response

Superscript 1 represents the functions that correspond to the state of the firm's marketing in reality and superscript 0 refers to the counterfactual condition if the firm had not undertaken any marketing expense (such as advertising) to shift its demand. The first step is to econometrically estimate the demand curve ($D^1 = P^1(Q^1, A)$) in the presence of advertising. From this estimate, we construct total revenue, $TR^1 = P^1(Q^1, A)Q^1$, in order to obtain marginal revenue, $MR^1 = MR^1(Q^1, A)$, by taking the derivative of the total revenue curve with respect to quantity and then evaluating this function at the observed Q^1 and ADV levels in the data. We derive marginal cost using the assumption of profit maximization $MR^1 = MC$.⁴

Measuring the Shift in Demand and Average Cost

The next step is to ascertain what the quantity and price would have been in the absence of any advertising (Q^0, P^0). To find marginal revenue with no advertising we set advertising equal to

³ The first AC formulation is often shown as a textbook case in presentations of monopolistic competition because it forces a firm to operate in the downward sloping portion of its average cost curve, as this AC function asymptotes on the fixed marginal cost as quantity increases.

⁴ In the case of constant MC , we have $MR^1 = c$ and in the case of increasing MC , we solve for g in $MR^1 = 2gQ^1$.

zero in our MR^1 function to get MR^0 . In monopolistic competition, quantity in the counterfactual condition exists where marginal revenue equals marginal cost and where the demand and average cost functions are tangent. When $ADV = 0$, AC^0 is the average cost function and D^0 is the price-dependent demand function. We simultaneously solve $MR^0 = MC$ and

$$(5) \quad \frac{dAC^0}{dQ^0} = \frac{dD^0}{dQ^0}$$

for Q^0 and the level of non-advertising fixed cost, a . Once Q^0 is determined, counterfactual price, P^0 , is found using Q^0 in the demand curve without advertising. Because the only difference between AC^1 and AC^0 is ADV , AC^1 is:

$$(6) \quad AC^1 = \frac{a}{Q^1} + c + \frac{ADV}{Q^1}$$

in the case of constant marginal cost and

$$(7) \quad AC^1 = \frac{a}{Q^1} + gQ^1 + \frac{ADV}{Q^1}$$

in the case of increasing marginal costs.

Finally, we must construct and interpret the benefit-cost ratio, BC . Under monopolistic competition, economic profits at (Q^0, P^0) in figure 1 are zero by construction. If there is no change in profits from undertaking the advertising, then $\pi^0 = \pi^1$

$$(8) \quad P^0 Q^0 - AC^0 Q^0 = P^1 Q^1 - AC^1 Q^1.$$

In such a case, the ratio

$$(9) \quad BC = \frac{P^1 Q^1 - P^0 Q^0}{AC^1 Q^1 - AC^0 Q^0} = 1$$

defines the change in revenues divided by the change in costs. If $\pi^1 > 0$, then $BC > 1$ means advertising contributed more to revenues than to costs and $BC < 1$ means the advertising harmed the firm.⁵

The U.S. Prune Industry and Monopolistic Competition

The most commonly used test for monopolistic competition is that of Panzar and Rosse (1987). The Panzar-Rosse test and its variants examine firm revenues to test among perfect competition, monopoly, and monopolistic competition. The model requires not only a panel of firm-level data—including data for each firm's input costs—but also presumes that firms are operating in a long-run equilibrium where price is equal to average cost. In our case, the Panzar-Rosse test is unsuitable not only because we lack the necessary input costs but also because we assert that Sunsweet is trying to break free from a long-run equilibrium.

Much of the literature on monopolistic competition simply asserts its presence based on evidence from the industry of interest. There are many such examples, especially in the areas of international trade and retail financial services, including Krugman (1979), Lenclos and Hertel (1995), Heffernan

⁵ A study of figure 1 shows that as long as the shifts in D and AC are parallel, BC is non-negative. However, there are two cases to also consider. First, if the shifts are not parallel, theoretically one could obtain a negative BC using the definition in equation (8). Second, a case can occur where profits are negative regardless the shape of the cost and revenue functions, but BC is still positive as long as the difference in revenue in BC (numerator) is greater than the difference in costs (denominator). This is why $BC > 1$ and $\pi^1 > 0$ are both necessary. Though perhaps unlikely, in either of these cases one can simply report the profit change instead of BC .

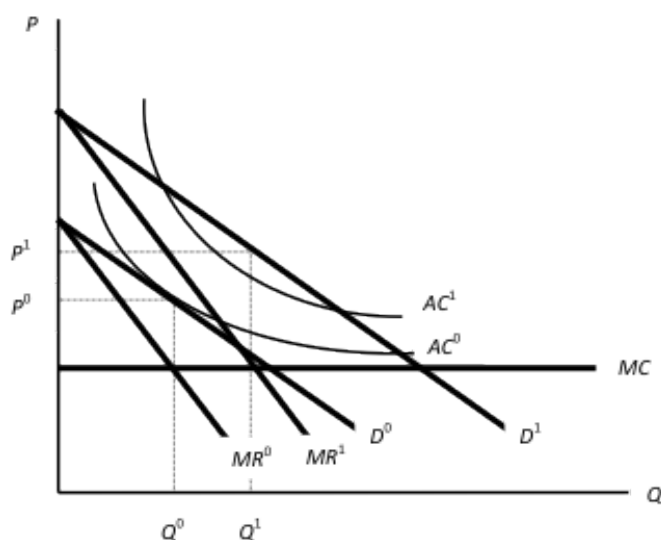


Figure 1. Beneficial Short-Term Advertising under Monopolistic Competition.

(2002), Coto-Martínez (2006), Feenstra and Taylor (2008), Ruan, Gopinath, and Buccola (2008) and Feenstra and Weinstein (2010). Studies of the food sector are few and nearly entirely devoted to the use of the theory in the trade of food and agricultural goods. This is especially true in the literature on intra-industry international trade, where Sheldon (2006, p. 26) argues that “the monopolistic competition model has become the dominant theoretical alternative to the neoclassical model” and offers empirical evidence to support that theory for trade in food and agricultural products.

Industrial Organization of U.S. Prune Industry

The industry sector for Dried and Dehydrated Food (NAICS code 311423) has mostly escaped the increasing concentration seen in other food sectors, with a four-firm concentration ratio in 2007 of only 35.9% (U.S. Department of Commerce, June 2010). Within this sector, per-capita prune consumption has been declining for a number of years. In 1996, U.S. prune growers produced about 200,000 tons of prunes. Today this number has fallen by about 60,000 tons (U.S. Department of Agriculture, National Agricultural Statistical Services, June 2009); the decline is in both U.S. domestic and export markets. Yet while demand has declined, the number of competitors has increased. In the 1990s there were three major firms selling prunes in the domestic, branded market: Sunsweet, Del Monte, and Dole (Alston et al., March 1998). Of these, Sunsweet had nearly 80% of the retail market share (Crespi and Marette, 2002). Today, there are six major players including private label, and Sunsweet’s retail share has dropped to less than 60%.⁶ Although not definitive evidence, Dixit and Stiglitz (1977) note that a decrease in quantity demanded coupled with an increasing variety of products is one of the possible outcomes of monopolistic competition.

Advertising, Promotion, and Product Development

Sunsweet uses both television advertising and marketing promotions, while its competitors rely almost entirely on marketing promotions. Firms selling homogeneous products under either perfect competition or under oligopoly (where prices are nearly identical across competitors) forgo most advertising because of the free-rider effect noted by Alston et al. (2007). Firms in oligopolies with

⁶ The major public brands are Sunsweet, Sun Maid, Dole, Del Monte, Mariani, and Champion.

differentiated products, on the other hand, create large barriers to entry when those few firms all advertise (e.g., Coke and Pepsi in the carbonated beverage industry). This advertising is successful if it maintains the industry status quo, as discussed by Sutton (1991). Sunsweet increased advertising of its prunes in 1996 when there were only two other major competitors. The increase in number of firms since 1996 suggests that advertising is not a significant barrier to entry, giving further credence to the Dixit and Stiglitz (1977) result that declining demand and increased variety come about under monopolistic competition if fixed costs (e.g., advertising) are low barriers to entry.

Prunes are Differentiated

Prune brands are clearly differentiated, as can be seen in the per-unit prices of retail prunes. A comparison of retail prices per pound of the least and most expensive brands in our data shows prices nearly twice as high for the most expensive brand. Making the same comparison for the second-highest priced brand and the second-to-lowest priced brand reveals a 32% premium. In other words, the brand-to-brand price differences are well above the typical marketing margins for retail products. Given that the underlying input is similar across firms, cost cannot be the only explanation for price differences and consumers are clearly not regarding brands of prunes as perfect substitutes. Product variety from more than just a few firms is a key assumption of monopolistic competition.

Data Description

The data used for this research are U.S. branded product, weekly data from July 20, 2008, through June 13, 2010, resulting in 100 observations. Recently, Sunsweet developed a new product in an effort to differentiate prunes. The board of directors debated this differentiation strategy over several years and ultimately hired a new CEO to undertake this new strategic direction. The specific product is Sunsweet *Ones*, individually wrapped dried prunes that come in a canister containing approximately twenty prunes. Sunsweet's advertising promotes the nutritional value associated with prunes.⁷ No other firm has a similar product line.

The regression model and choice of data was influenced by the evaluation of the California Prune Board's Promotion Program conducted by Alston et al. (March 1998). Table 1 provides a detailed listing of the variables, units and sources used in our econometric models and table 2 presents the summary statistics.

The quantity of *Ones* (Q) was provided by Sunsweet from their Infoscan IRI database of weekly prune sales across the United States, representing approximately 86% of Sunsweet's total sales. The variable represents total pounds of Sunsweet *Ones* prunes consumed in the United States for the specified week. There are multiple price variables used in this model: the *OnesP* variable and *SunP* variable represent average price per pound of Sunsweet *Ones* prunes and other Sunsweet prunes, respectively. Because the analysis presented previously was for a firm, we wanted to use prices as close to possible to what Sunsweet actually receives as opposed to retail level prices. After consulting with Sunsweet's marketing department, these data were multiplied by a markdown percentage of 59% to convert retail prices to Sunsweet's estimate of its received price.

Sunsweet also provided data on the quantities and price per pound of five of Sunsweet's largest competitors. The prices of the competitors are Private Label Pricing (*PLP*, an aggregation of in-store store brands in the Infoscan IRI data), Sun Maid Pricing (*SMP*), Mariani Pricing (*MP*), Del Monte Pricing (*DMP*), and Champion Pricing (*CP*). All prices were adjusted to 2010 dollars using

⁷ A reviewer pointed out that a model of profit-maximization may only be a proxy for a firm like Sunsweet, which is a cooperative and not a private firm. This is a good point and the interested reader is referred to Staatz (1983) and Sexton (1986a,b) for discussions of this issue. Rather than provide a model for the optimal setting of advertising in a cooperative setting, however, we acknowledge the issue and continue with the present formulation on the data at hand, since most estimations using this technique are likely to be for profit-maximizing firms and it is arguably a useful proxy for this cooperative.

Table 1. Definitions, Units, and Sources of Variables Used in this Study

| Variable | Definition | Units | Data Source |
|------------------------------------|--|---|--|
| <i>Q</i> | Weekly volume sales of Sunsweet’s <i>Ones</i> prunes. | Pounds | Infoscan IRI data provided by Sunsweet |
| <i>OnesP</i> | Average price of Sunsweet <i>Ones</i> prunes to the retailers. | Real dollars (2010) per pound | Retail prices from Infoscan IRI data provided by Sunsweet and deflated by CPI from the Bureau of Labor Statistics. |
| <i>SunP, PLP, SMP, MP, DMP, CP</i> | Average price of Sunsweet’s other prunes, private label, Sun Maid, Mariani, Del Monte and Champion brand prunes, respectively, to the retailers. | Real dollars (2010) per pound | as above |
| <i>Income</i> | Yearly average personal income. | Personal income by quarter in real dollars (2010) | Per-capita income from the Bureau of Economic Analysis and adjusted by CPI |
| <i>Trend</i> | Time trend | 1,2,3,.....100 | |
| <i>Summer, Spring, Winter</i> | Summer, Spring, Winter Dummy Variables, respectively. | | |
| <i>ACVDisp, ACVFeat, ACVFD</i> | Percentage all commodity value of retail stores with a feature, display and feature and display, respectively, aggregated for all brands. | Percentage | Infoscan IRI data provided by Sunsweet |
| <i>ADV, ADV1-ADV5</i> | Weekly budgeted expenditures for <i>Ones</i> advertising and respective weekly lags. | Real dollars (2010) per week of advertising | Expenditures correspond to weekly advertisements provided by Sunsweet and adjusted by CPI |

Table 2. Summary Statistics for the Variables used in this Study

| Variable | N | Mean | Standard Deviation | Minimum | Maximum |
|--------------------|-----|----------|--------------------|----------|----------|
| <i>Q</i> | 100 | 36,614.2 | 11,791.2 | 15,864.1 | 58,734.8 |
| <i>OnesP</i> | 100 | 3.6 | 0.1 | 3.3 | 3.7 |
| <i>SunP</i> | 100 | 2.6 | 0.2 | 2.1 | 2.8 |
| <i>PLP</i> | 100 | 1.8 | 0.04 | 1.7 | 1.9 |
| <i>SMP</i> | 100 | 2.6 | 0.1 | 2.5 | 2.8 |
| <i>MP</i> | 100 | 1.9 | 0.1 | 1.5 | 2.2 |
| <i>DMP</i> | 100 | 2.1 | 0.2 | 1.2 | 2.3 |
| <i>CP</i> | 100 | 2.2 | 0.2 | 1.3 | 2.5 |
| <i>Income</i> | 100 | 35,915.9 | 314.0 | 35,158.5 | 36,531.1 |
| <i>Trend</i> | 100 | 50.5 | 29.0 | 1.0 | 100.0 |
| <i>ACVDisp</i> | 100 | 31.4 | 4.4 | 20.8 | 40.1 |
| <i>ACVFeat</i> | 100 | 3.3 | 2.0 | 0.6 | 10.2 |
| <i>ACVFeatDisp</i> | 100 | 0.9 | 0.7 | 0.0 | 4.2 |
| <i>ADV</i> | 100 | 9,887.9 | 13,571.3 | 0.0 | 29,625.0 |

the U.S. Department of Commerce Bureau of Labor Statistics Consumer Price Index (CPI) and multiplied by a 59% markdown to convert retail prices to processor prices. All price variables represent the weighted average price per pound of prunes nationally. 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 and, thus, reflect promotional price discounts at the point of sale.

Income is U.S. quarterly per-capita personal income adjusted to 2010 dollars using the CPI. Alston et al. (March 1998) found that consumption of prunes varies by season. Seasonal dummy

variables denote *Summer* (July–Sept.), *Spring* (April–June), *Winter* (Jan–Mar); fall (Oct–Dec) is used as the base season. The seasonal dummy variables are given a value of one for each month with a majority of its days in a given season and zero otherwise.

The Infoscan IRI data contained information regarding in-store, non-advertising promotions. These are a measure of the “Percentage All Commodity Value” of retail stores using trade merchandising “reach” or “depth” of support for a product. That is, the percentage of stores in terms of annual sales that sold the product with some type of merchandising—such as features (*ACVFeat*), displays (*ACVDisp*), or combinations of the two (*ACVFD*)—during the sample period. A feature is a product promotion without a display such as newspaper advertisement or a store mailing. A display is a promotion using an in-store display without being otherwise advertised at or by the store.⁸ As described by Crespi and Marette (2002, p. 696), these variables are “roughly dummy variables weighted by store size that show whether a particular promotion was occurring in a store at time t .”

The relationship between Sunsweet’s advertising of its *Ones* product (*ADV*) and the function A in the theoretical model was chosen to be a simple linear combination of present day and lagged advertising expenditures. In the model presented in this paper, the cost of advertising is borne by the sales of the product. For a multi-product firm such as Sunsweet, budgets are fungible, so the cost-share for any single product must be derived. After reviewing Sunsweet’s budgets and consulting with Sunsweet’s marketing department regarding cost shares, advertising-to-sales expectations and timing and types of media exposures, the advertising variable was constructed and adjusted by the CPI Index for all *Ones* television advertising over the sample period.⁹ Because advertising effects need not be instantaneous, we constructed five lagged advertising variables (*ADV1*–*ADV5*), where *ADV1* is *ADV* lagged one week, *ADV2* is *ADV* lagged two weeks, etc.

Finally, a time trend variable was added to the model (*Trend*) to account for other factors affecting prune consumption as suggested by Alston et al. (March 1998). We know that prune consumption has declined over time, so we may expect the sign of this variable to be negative. 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 California Dried Plum Board with respect to generic advertising. We did not have access to data on the generic advertising for prunes that is conducted by the California Dried Plum Board. Our assumption is that this advertising affects all firms in similar ways, but to the extent its absence biases the results, we do note this caveat.¹⁰

Estimation of Econometric Model Parameters

For comparison, we estimated a linear specification and a constant-elasticity or double-log specification for the demand functions using ordinary least squares. We lacked useful weekly instruments to control for potential endogeneity, but the Alston et al. (March 1998) study on prune

⁸ Models were estimated using these variables for Sunsweet and each of its competitors, which not only greatly reduced the degrees of freedom but also revealed problems with multicollinearity (many of these marketing specials run in tandem). Nonetheless, they did add to the fit of the model and removing them was not an option. We chose instead not to use these variables in their firm-level form and instead aggregated each of them. These variables essentially proxy all firm or store expenditures on marketing excluding television advertising expenditures and can be best thought of as representing promotion but not advertising.

⁹ Sunsweet’s total advertising budgets for all of its prune and non-prune product lines annually averaged \$26 million during the sample period, amounting to roughly 8% of its annual net sales revenue (Sunsweet Growers, 2010). The amount spent on *Ones* was between 3% and 5% of net sales. During the sample period, all of Sunsweet’s prune-related advertising was devoted to the *Ones* product and a prune juice called *PlumSmart* in order to position these new products in the market. Sunsweet took this strategy for three reasons: the launch of a new product, market penetration into new outlets such as drug stores (e.g., Walgreens), and the belief that advertising *Ones* also helped increase demand for all of its other products.

¹⁰ A reviewer asked why an industry with differentiated products would also have a generic advertising program. We asked members of management and the board who indicated that the answer is historical. The California Dried Plum Board, previously the California Prune Board, was established in 1952 when the focus was the marketing of a commodity.

Table 3. Regression Results for Sunsweet *Ones* Brand under Linear and Constant Elasticity Specifications

| | Coefficient | Std Err | Elast | Coefficient | Std Err |
|---|-----------------------------------|-----------|-------|--|---------|
| | Linear Specification ^a | | | Constant Elasticity Specification ^a | |
| <i>Constant</i> | -98,876.80 ^{ab} | 52,637.20 | | -52.57*** | 20.84 |
| <i>Sunsweet Ones Price</i> | -10,642.10*** | 2,301.00 | -1.74 | -1.81*** | 0.41 |
| <i>Sunsweet Other Price</i> | 1,132.51 | 2,320.10 | 0.08 | 0.12 | 0.18 |
| <i>Private Label Price</i> | 17,945.36 | 14,268.90 | 0.90 | 1.04 | 0.81 |
| <i>Sun Maid Price</i> | -11,885.90* | 6,848.90 | -0.86 | -0.22 | 0.54 |
| <i>Mariani Price</i> | -1,430.65 | 4,531.00 | -0.08 | -0.01 | 0.25 |
| <i>Del Monte Price</i> | -376.63 | 2,477.80 | -0.02 | -0.05 | 0.12 |
| <i>Champion Price</i> | 7,681.11*** | 2,628.40 | 0.46 | 0.22 | 0.15 |
| <i>Income</i> | 4.07** | 1.86 | 3.99 | 5.48*** | 2.03 |
| <i>Trend</i> | 34.32 | 35.46 | | 0.001 | 0.001 |
| <i>Summer</i> | -346.92 | 1,161.20 | | -0.02 | 0.03 |
| <i>Spring</i> | 610.63 | 1,135.30 | | 0.001 | 0.04 |
| <i>Winter</i> | 4,621.46*** | 969.50 | | 0.12*** | 0.03 |
| <i>ACV Display</i> | 736.54*** | 226.00 | | 0.84*** | 0.21 |
| <i>ACV Feature</i> | 196.95 | 262.70 | | 0.03 | 0.03 |
| <i>ACV Feature & Display</i> | -123.99 | 603.00 | | -0.01 | 0.02 |
| <i>Ones Advertising</i> | 0.011*** | 0.002 | 0.060 | 0.013*** | 0.002 |
| <i>Ones Advertising Lag 1</i> | 0.012*** | 0.001 | 0.067 | 0.014*** | 0.002 |
| <i>Ones Advertising Lag 2</i> | 0.010*** | 0.002 | 0.053 | 0.011*** | 0.002 |
| <i>Ones Advertising Lag 3</i> | 0.005*** | 0.002 | 0.028 | 0.009*** | 0.002 |
| <i>Ones Advertising Lag 4</i> | 0.003* | 0.001 | 0.016 | 0.005*** | 0.002 |
| <i>Ones Advertising Lag 5</i> | 0.004** | 0.002 | 0.020 | 0.005*** | 0.002 |
| <i>Long Run Advertising Elastic^c</i> | | | 0.211 | 0.056 | |
| Adjusted R ² | 0.944 | | | 0.943 | |

Notes: ^a Dependent variable is quantity sales (lbs.) and logged quantity sales, respectively.

^b Single, double, and triple asterisks (*, **, ***) represent significance at the 10%, 5%, and 1% level.

^c Long-run advertising elasticity is the aggregation of the short-run elasticities.

demand found no appreciable difference in demand estimations whether endogeneity was controlled for or not. We estimate the models in their quantity-dependent form.

Table 3 shows the coefficient, elasticities, and other statistics for Sunsweet's *Ones* demand regression using both the linear specification and the constant-elasticity specification. Both specifications had an adjusted R² of 0.94 and both models show that the price and advertising coefficients were significantly different from zero. The price elasticities for both models are similar at -1.74 on average for the linear specification and -1.81 for the constant elasticity specification. The *Ones* product appears priced in the elastic region of the demand functions, which is necessary for a firm with price-setting ability.

The advertising elasticities are positive and significant in both models and decline with lags as expected. The advertising elasticities were quite different for the two models, as can be seen in the sum of the elasticities over the lags. The long-run elasticity is 0.21 for the linear specification but only 0.06 for the constant-elasticity case, which affects how the benefits to advertising are determined; we should expect to see lower benefit-cost measures for the constant-elasticity demand specification. The income coefficient is positive and significant in both models consistent with prunes being a normal good. Seasonality appears correlated with demand for *Ones* with winter months correlated with higher demand. The effect appears in both models and was also found by Alston et al. (March 1998).

While a number of coefficients in both models were insignificant, we chose to leave the variables in the models in part as proxies for variables we may be missing. For example, while the other prices, with perhaps the exception of Champion and Sun Maid prunes in the linear specification, add no significant change based upon the standard errors of the coefficient values, an F-test revealed that jointly these price coefficients are significant in both specifications.

Likewise, the *ACV Display* coefficient is positive and significant in both specifications, suggesting promotional displays placed in stores do increase demand, but the *ACV Feature* and *ACV Feature & Display* coefficients are insignificant in both models. An F-test revealed that these coefficients were jointly significant.¹¹

Deriving the Benefit-Cost Measures

We estimated the benefits and costs for Sunsweet's advertising of its *Ones* product using the previously estimated parameters. We inverted both demand functions to be price-dependent. Along with the two demand specifications, we also performed further simulations. We estimated the impacts for the point estimates over our 95 usable observations for both demand formulations and for the two formulations of the cost functions. Then we performed Monte Carlo analyses by perturbing the error term of the econometrically estimated demand function 1,000 times per observation (95,000 total draws), based upon the standard error of the estimated equation. From this analysis we constructed the means and 95% confidence intervals on the estimated benefit-cost ratios.

Table 4 presents the quantities, prices, costs, and benefit-cost results generated for the models under the two demand specifications and the two cost scenarios.¹² Marginal cost per pound varies slightly depending on the scenario of interest. The average MC^0 ranges from \$1.37 to \$1.59 and MC^1 ranges from \$1.46 to \$1.77. In all cases the average cost in the presence of advertising is less than price in the presence of advertising.¹³

The bottom three rows of table 4 provide the benefit-cost estimates. Depending on the simulation, a \$1.00 expenditure on the advertising of the *Ones* product results in a \$1.26 to \$4.35 average return. The benefit-cost ratio appears sensitive to the specification of the demand function. Lower benefit-cost estimates appear in the constant-elasticity demand specifications, which is consistent with that demand model's lower estimate of the advertising elasticity and restriction on price changes due to the elasticity restrictions. Which demand specification is correct is arguable, but given that the constant-elasticity specification is more restrictive on a key parameter in the simulation, future researchers should be aware of the differences. Nevertheless, the benefit-cost measures are, on average, above one in all cases.¹⁴

The Monte Carlo analysis shows that the confidence intervals include benefit-cost estimates below one. A review of the output revealed a number of observations where extremely large estimates of average cost were created, over \$5.00 per pound in some cases. In other words, there were some observations where the model predicts that Sunsweet was making extremely large losses on its advertising. As long as the benefits exceeded the costs on average, however, Sunsweet was benefiting from the advertising.

¹¹ A system of regressions using the quantities for all of the other prune brands is available from the authors upon request. One result of interest from those models is that the higher-priced product, *Ones*, is being sold on a region of its demand curve where price response is less elastic than that of Sunsweet's lower-priced substitute. This is commensurate with the goal of successful differentiation.

¹² In each scenario, the variables Q^0 and a are found using the "solve" routine under SAS 9.2's "proc model" command.

¹³ When the demand specification restricts price elasticity to be the same in the advertising and non-advertising scenarios and the cost specification is one of constant marginal costs, P^1 and P^0 must be equal, with any change in revenue coming from quantity changes. Marginal revenue is $MR^i = P^i(1 + \epsilon^{-1})$, where $i = 0, 1$, and $\epsilon < 0$ is the own-price elasticity of demand. Since ϵ is constant and MC^0 equals MC^1 , then setting marginal revenue equal to marginal cost forces P^1 to equal P^0 . Table 4 shows that average cost actually falls in this case because of the very large increase in quantity.

¹⁴ As a check of diminishing returns, we simulated increases in the cost of the advertising finding that it would require slightly more than a doubling of the advertising cost before the benefit-cost ratio dropped below one.

Table 4. Averages for Simulation Variables and Benefit-Cost Estimates

| Variable | Constant MC | Increasing MC |
|---|------------------|------------------|
| Linear Demand Specification | | |
| Q^1 (pounds) ^{a,b} | 37,635 | 37,635 |
| Q^0 (pounds) ^a | 33,010 | 33,840 |
| P^{1a} | \$3.55 | \$3.55 |
| $P^0 = AC^{0a}$ | \$3.29 | \$3.25 |
| MC^{1a} | \$1.46 | \$1.46 |
| MC^{0a} | \$1.46 | \$1.37 |
| AC^{1a} | \$3.31 | \$3.30 |
| <i>Benefit-Cost</i> ^a | \$2.73 | \$3.47 |
| <i>Benefit-Cost, Monte Carlo</i> ^c | \$3.35 | \$4.35 |
| | (\$0.57, \$6.40) | (\$0.57, \$8.02) |
| Constant-Elasticity Demand Specification | | |
| Q^1 (pounds) | 37,585 | 37,585 |
| Q^0 (pounds) | 27,484 | 35,547 |
| P^1 | \$3.55 | \$3.55 |
| $P^0 = AC^0$ | \$3.55 | \$3.13 |
| MC^1 | \$1.59 | \$1.77 |
| MC^0 | \$1.59 | \$1.40 |
| AC^1 | \$3.33 | \$3.22 |
| <i>Benefit-Cost</i> ^a | \$1.26 | \$2.91 |
| <i>Benefit-Cost, Monte Carlo</i> ^c | \$1.73 | \$3.19 |
| | (\$0.77, \$2.23) | (\$0.75, \$4.87) |

Notes: ^a Results are from the 95 observations in the data set.

^b Q^1 is the predicted value from the demand regressions.

^c Monte Carlo estimates are for 95,000 random simulations with 95% confidence intervals given in parentheses.

Conclusion

The agricultural economics literature does not have any examples of benefit-cost measures for firm-level advertising in an industry typified by monopolistic competition. A study of prunes provides a story consistent with firms operating under monopolistic competition. There are several firms operating in the marketplace, suggesting that barriers to entry are surmountable: this industry had fewer national firms in 1998 than in 2011, even though total demand has fallen substantially. Prunes are sold as branded products. Per-unit prices are substantially different for competing brands. Demand curves are downward sloping and firms are selling on the elastic portion of their demand curves, and brand advertising affects demand for the product being advertised.

This paper develops a theoretical framework of how a firm in such an industry can use advertising in the short run to move its demand away from the tangency condition with its average cost to obtain economic profit before increased differentiation, increased entrance, or increased advertising on the part of rivals return the firm to pricing at average cost. Using data gathered for the retail prune industry, we examine such a model for the case of the Sunsweet Growers' marketing of its new line of prunes called *Ones*. The simulations show that the benefits of the advertising on average exceeded the costs on the order of \$1.26 to \$4.35 for every dollar expended advertising the new product.

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