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Does Branded Food Product Advertising Help or Hurt Farmers?

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This study investigates market conditions when food processor/handler brand advertising, whether undertaken by an investor-owned firm or by a cooperative, will benefit or harm farmers. Addressing this question provides insight into the policy issue of whether and when promotion funds intended to benefit farmers should be used in support of brand advertising. Analysis of a two-stage oligopoly-oligopsony model shows that advertising by an investor-owned firm is most likely to be harmful to farmers when it takes place in a relatively unconcentrated industry and when advertising is relatively more effective at creating brand market power than at increasing total demand.

Key words: advertising, brand, cooperative, farmer welfare, oligopoly, oligopsony

Introduction

An important issue for various commodity promotion programs is how to treat processor/handler brand advertising. In programs that include a handler assessment, should handlers be given credit toward their assessment for expenditures to advertise their own brands? Should program funds be used to subsidize advertising of handlers' brands? For example, the Florida Citrus Commission has used check-off funds to support advertising of well-known brands, the Almond Board of California has used various programs which offer marketers assessment credits for brand advertising expenditures, and Market Promotion Program (MPP) funds from the U.S. Government are used to support brand advertising abroad.

Advertising is an important structural dimension of the U.S. food industry. In a study of food manufacturing industries, Connor et al. estimated food and tobacco manufacturers advertised 3.5 times more intensively than the rest of manufacturing. Brand advertising may assume even greater importance in U.S. agriculture in light of the 2001 Supreme Court decision in the case of *United States v. United Foods, Inc.* The Court ruled that assessments on mushroom handlers to fund generic advertising represented an unconstitutional infringement on the commercial speech rights of the handlers. Indeed, the plaintiff handler, United Foods, argued that, absent a mandatory advertising program,

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it would be free to design advertising campaigns to differentiate its products. Although the full implications of the *United Foods* decision will not be known for some time, likely consequences are greater expenditures on brand advertising relative to generic advertising and the redesign of mandatory promotion programs to recognize (credit) money expended promoting a brand.

To date, little research has been conducted on brand advertising's impact on demand for the farm products used as inputs in the food industry, but available evidence suggests it may be at least as effective in this regard as generic advertising (Hall and Foik; Kaiser; Kinnucan and Fearon). However, shifting demand may not be sufficient for brand advertising to benefit farmers if it also creates or solidifies processor/handler oligopoly power. Noted commentators on the market structure of the food industry argue that extensive brand advertising has been a key source of market power in the sector (e.g., Connor et al; Sutton). Also, a number of econometric studies (e.g., Pagoulatos and Sorensen; Wills and Mueller) have found a positive correlation between an industry's price or profitability and its advertising-to-sales ratio.

For a given market supply curve for the basic agricultural product, producer welfare, as measured by producer surplus, is a monotonic function of the market output. If market power increases as a consequence of brand advertising, the advertising firm will, ceteris paribus, increase consumer price and reduce sales, thereby also reducing sales of the farm product and reducing farmer welfare. Thus, even if brand advertising is successful in shifting demand, it may be harmful to farmers.

An additional factor in analyzing the impact of branded food-product advertising on farmer welfare is that the leading advertiser in several industries is a producer-owned cooperative. The benefits from market power exercised by a cooperative will accrue to its members, but producers who do not market through the cooperative may be harmed if the advertising cooperative increases its market share at the expense of rival firms.[1]

The goal of this research is therefore to investigate market conditions when processor/handler brand advertising, whether undertaken by an investor-owned firm or a cooperative, will benefit or harm farmers. Addressing this question will provide insight into the policy issue of whether and when promotion funds intended to benefit farmers should be used in support of brand advertising, and also will contribute to the debate on generic versus branded commodity promotion policy in light of the *United Foods* ruling.

We utilize a flexible oligopoly-oligopsony model to investigate the impacts of brand advertising on farmer welfare. The model is similar to that developed by Huang and Sexton and extended by Alston, Sexton, and Zhang to study the returns to agricultural research under alternative types of imperfect competition. Whereas these two studies examined exogenous research-induced shifts in farm supply, we investigate endogenous, advertising-induced shifts in consumer demand, and also allow the advertising expenditures to create or reinforce oligopoly behavior among sellers.

[1] See Rogers (1994, 1997) for discussion of advertising strategies by cooperatives in branded food-product markets. Also see Gruber, Rogers, and Sexton for a recent statistical analysis refuting the common belief that cooperatives advertise less intensively than investor-owned firms, ceteris paribus.

Advertising and Imperfect Competition

Before developing the model, it is helpful to differentiate this work from the considerable prior research conducted on advertising in imperfectly competitive markets. One useful distinction that has emerged in the literature is between persuasive and informative advertising. At the risk of oversimplifying, persuasive advertising is intended to change consumers' tastes by creating subjective product differentiation, whereas informative advertising provides consumers useful information, e.g., as to a product's existence, price, and/or characteristics. Results in the literature suggest the consumer and social welfare effects of advertising depend importantly upon whether the advertising is informative or persuasive.

The advertising considered here is best characterized as persuasive. Food product markets are mature, and consumers are generally well acquainted with the products and their characteristics. Moreover, advertising conducted by food manufacturers or commodity boards generally does not feature useful price information, but, rather, is intended to persuade consumers to purchase a particular product or brand.

Our focus throughout the analysis is on the farmer welfare implications of brand advertising, as opposed to a consumer or social welfare criterion. Producer welfare is the criterion specified in the legislation authorizing commodity-advertising programs and has received scant attention in the literature on brand advertising. In contrast, consumer and social welfare aspects have been studied extensively. Nevertheless, the subject is difficult and controversial. Findings concerning consumer welfare results depend upon modeling assumptions almost exclusively. We take these results as given, and focus our attention on producer welfare. For completeness, some highlights are summarized below.

Whether or not persuasive advertising benefits consumers depends upon how one interprets the demand shift associated with advertising. In their earlier study on advertising and welfare, Dixit and Norman concluded that the pre-advertising demand is appropriate for welfare evaluation if the advertising is purely deceptive. They determined, even using the pre-advertising demand for welfare evaluation, some advertising may be socially desirable in imperfectly competitive markets because advertising increases sales, which are distorted below the social optimum by the presence of market power. However, the equilibrium level of advertising was generally found to be excessive from a social welfare criterion.

In commenting on Dixit and Norman's work, Fisher and McGowan noted persuasive advertising may enhance the consumer's image of the product, and thus increase the utility from consumption. Becker and Murphy subsequently argued that Dixit and Norman's view of advertising was also limited because they assumed the advertising was free (i.e., advertising often has a negative price through subsidizing various media) and the advertisements do not directly provide utility. Under this expanded view, advertising may not be excessive even if it raises the price to consumers. Tremblay and Tremblay showed how to translate these alternative views of advertising's effects into traditional welfare analysis using consumer surplus.[2]

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[2] Not surprisingly, the welfare implications of informative advertising are more favorable than those for persuasive advertising. Pioneering studies demonstrated how informative advertising can increase welfare by informing consumers of a product's availability (Butters) and by better aligning consumers with suppliers (Grossman and Shapiro). Even in these cases, advertising may be excessive relative to the social optimum. Recent work on informative advertising has shown it can increase price competition, and thus expand the size of the market (Bester and Petrakis) or resolve price uncertainty in the market (LeBlanc).

An additional strand of the advertising literature is highlighted here due to its relation to the present study—the work on advertising bans, e.g., for cigarettes (Farr, Tremblay, and Tremblay) or distilled spirits (Tremblay and Okuyama). Although our analysis does not consider banning branded food-product advertisements per se, the issue of whether to allow branded advertising under the auspices of commodity advertising programs has similar features; i.e., we evaluate the market equilibrium with brand advertising relative to an equilibrium with no advertising. Moreover, Farr, Tremblay, and Tremblay, and Tremblay and Okuyama each emphasize that proper evaluation of the effect of an advertising ban on consumption must consider both the demand-expansion and market-power impacts of advertising.

The Basic Model

A food processor is assumed to convert raw product q into processed product g according to the fixed-proportions production function $g = \min\{q/\kappa, h(\mathbf{Z})\}$, where $\mathbf{Z}$ is a vector of processing inputs, and $\kappa = q/g$ is the fixed conversion rate between raw and processed product. Without loss of generality, we can set $\kappa = 1$ through choice of measurement units, so $q = g$. The cost function associated with this production function is $C(q) = m(Q)q + c(q)$, where Q is total industry output, $m(Q)$ is the industry inverse supply function for the farm product, and $c(q)$ is the processing firm's cost associated with the processing inputs $\mathbf{Z}$. It will be convenient to assume the processor operates with constant marginal processing costs, and hence $c(q) = cq$.

We consider a fixed number, n, of processing firms. Entry is not an issue, and thus fixed costs of production, if any, play no role in the analysis and are ignored.[3] We assume firm 1 in this industry produces both a branded and a nonbranded product. The products are essentially undifferentiated except that the branded product is advertised. The remaining $n - 1$ firms ($i = 2, 3, ..., n$) produce only a nonbranded product which is identical to the first firm's nonbranded product. Without the first firm's brand advertising, all products are homogeneous, and all firms face the same market demand. Firms engage in quantity competition in the homogeneous product market. Firm 1's brand advertising segments the retail market and creates monopoly market power for firm 1 in the branded market, and may also expand the total market.[4]

A notable feature of this model is that processors may exercise oligopsony power in the raw-product market, because collectively they face an upward-sloping supply curve, $W(Q)$, $W'(Q) > 0$, for the raw product. Oligopsony is important to consider in food market contexts, given various structural dimensions of many raw-product markets are

[3] The equilibria derived here should accordingly be interpreted as short-run equilibria. Authors like Connor et al., and Sutton have emphasized that advertising may represent an endogenous sunk cost and thereby constitute a barrier to new entry. Given fixed n, this potential entry-deterring effect of advertising plays no role in our analysis.

[4] We do not model formally the manner in which one firm is able to establish itself as the advertising firm. Because this firm earns greater profits than firms producing only the unbranded version of the product, it is reasonable to ask how the advertising firm is able to emerge. Several possibilities are apparent. Most notably, once a firm has moved first and established a brand identity, the payoff to other firms from subsequent efforts at brand establishment is less, and perhaps not worth the investment. Also, if advertising is used to create subjective vertical (quality) differentiation in consumers' minds, then equilibria exist when only one firm advertises. This is true despite products being formally identical (Tremblay and Martins-Filho; Tremblay and Polasky), because the vertical differentiation achieved by a single firm's advertising diminishes price competition in the market, which benefits both the advertising and nonadvertising firms.

suggestive of imperfect competition (Rogers and Sexton; Rogers 2001) and evidence of processor oligopsony power has been found in various recent empirical studies.[5]

We utilize a two-stage game formulation. In stage 1, firm 1 decides its expenditure on brand advertising, and in stage 2, the firms compete in quantities, given the brand identification created in stage 1.[6] Subgame perfect equilibrium is the appropriate solution concept for this game and is derived by backward induction, beginning with the stage 2 competition. Market equilibria in both the presence and absence of brand advertising are derived. We then compare farmer welfare both with and without brand advertising and undertake simulation analyses to isolate market conditions in which brand advertising is likely to increase or decrease farmer welfare.

The model captures in a simple and tractable way the observation that many agricultural industries are characterized by a single major branded-product processor and a broad unbranded or generic market segment. Examples in the United States include processed cheese and Kraft, butter and Land O' Lakes, almonds and Blue Diamond, prunes and Sunsweet, citrus and Sunkist, cranberries and Ocean Spray, grape juice and Welch's, canned vegetables and Del Monte, catsup and Heinz, avocados and Calavo, apple sauce and Motts, canned mushrooms and Georgio, and raisins and Sunmaid.

Equilibrium When the Advertising Firm Is an Investor-Owned Firm

To provide a benchmark for comparison, we first derive the market equilibrium without advertising. The total market demand is specified as:

$$D(P) = Q = a - \alpha P, \tag{1}$$

where $a > 0$, $\alpha > 0$, $Q = \Sigma_{i=1}^{n} q_i$ is output, n is the total number of processing firms, and P is the output price.[7] In the market without advertising, we assume processing firms are symmetric so that $q_i = q_j = q$, and $Q = nq$.

The inverse raw product supply is given as:

$$W(Q) = b + \beta Q, \tag{2}$$

where $b \geq 0$ and $\beta > 0$. The analysis is simplified with no loss of generality by normalizing some variables. The supply and demand curve intercepts, a and b, can be eliminated from the subsequent analysis by choosing units of measurement so that the aggregate quantity and retail price at the competitive equilibrium (denoted by a subscript c) without advertising (denoted by a superscript 0) are both normalized to 1.0. Thus, we set:

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[5] Rogers and Sexton list four structural characteristics which distinguish agricultural markets from other input markets and cause concern about processor/handler oligopsony power. Refer to Richards, Patterson, and Acharya and the references they cite for examples of empirical studies finding evidence of processor oligopsony power.

[6] This sequence of play is consistent with the persuasive form of advertising. Firms advertise first in an attempt to influence consumer tastes and preferences, and then decide price or output based upon the results of the advertising (Tremblay; Tremblay and Polasky). When advertising is informative, it may be appropriate to reverse the sequence of play. For example, firms may set price or output in stage 1, and then communicate information about the price or availability of the product to consumers in stage 2 (LeBlanc; Tremblay).

[7] Linear demands are consistent with utility maximization, as demonstrated by Hausman. A utility function framework is often utilized in advertising studies seeking to measure consumer welfare. Given our focus on producer welfare, we lose nothing by beginning with the market demand specification.

$$q_c^0 = \frac{1}{n}, \quad Q_c^0 = nq_c^0 = 1, \quad P_c^0 = 1, \quad \text{and} \quad W_c^0 = 1 - c = f, \tag{3}$$

where $f = 1 - c$ measures farmers' share of the retail product value under perfect competition, and n is the number of processing firms. The relations among the parameters are thus: $a = 1 + \alpha$, and $b = 1 - c - \beta = f - \beta$.

In addition, the demand and supply slope parameters α and β can be expressed in terms of the price elasticity of farm supply and the absolute price elasticity of retail demand (ε and η, respectively), each evaluated at the competitive equilibrium without advertising as follows:

$$\alpha = \eta \quad \text{and} \quad \beta = \frac{f}{\varepsilon}. \tag{4}$$

A representative firm's objective function is expressed as:

$$\text{Max}\{q\}\ \Pi = [P(Q) - W(Q) - c]q. \tag{5}$$

Given homogeneity among sellers, the first-order condition to (5) is readily solved in conjunction with (1) and (2) to yield the Cournot equilibrium without advertising:

$$q^0 = \frac{1}{n+1}, \quad Q^0 = nq^0 = \frac{n}{n+1}, \quad P^0 = 1 + \frac{1}{(n+1)\eta}, \quad W^0 = f_c\left[1 - \frac{1}{(n+1)\varepsilon}\right]. \tag{6}$$

Equilibrium with Brand Advertising

Now assume firm 1 can utilize brand advertising to segment the retail market and create monopoly market power for its branded product. This is represented by the impact on the branded product's market share. The same advertising may also increase total demand. Specifically, assume the demand for firm 1's branded product can be written as:

$$q_B = \left[a + z(A) - \alpha P_B\right]S(A), \tag{7}$$

where subscript B denotes the branded product; A is firm 1's brand advertising expenditure; S, $0 < S(A) < 1$, is the branded product's share of the total market demand; and $z(A) > 0$ denotes advertising's effect on total demand.[8] The elasticity of brand sales with respect to advertising, μ_B, can be expressed as $\mu_B = \mu + \mu_S$, where μ is the elasticity of total demand with respect to brand advertising, and μ_S is the elasticity of the branded

[8] The demand specification in (7) allows brand advertising to both increase total demand in the product category and influence the share of the total consumers electing to purchase the branded product. These consumers' purchases are a function of the branded product's price, but the consumers do not view the branded and unbranded products as direct substitutes. Halligan and Joerding used a similar specification, but the present model is more general; Halligan and Joerding depicted market demand as solely a function of advertising, with the price level held constant. Clearly, other representations of the branded-unbranded product relationship are also plausible. For example, a referee suggested a Mussa-Rosen (M-R) model of product differentiation could be adapted to analyze the present problem. The M-R model allows substitution, albeit of a particular form, between high-quality (i.e., branded) and low-quality (i.e., unbranded) products. The M-R model has been applied by Mills, and also by Bontems, Monier-Dilhan, and Réquillart in a related context, namely the competition between national brands and private labels. The essential feature from a modeling perspective is to incorporate in a parsimonious way the notion that brand advertising can create market power for the advertised brand. Indeed, such power is presumably the key factor motivating persuasive forms of advertising.

product's market share with respect to brand advertising. From (1) and (7), the total demand for the nonbranded product (subscript N) is:

$$Q_N = [a + z(A) - \alpha P_N][1 - S(A)]. \tag{8}$$

We represent advertising's effects on total demand and brand share as follows:

$$z(A) = \gamma_0(A)^{0.5} \quad \text{and} \quad S(A) = \gamma_1(A)^{0.5}, \tag{9}$$

where γ_0 and γ_1 are advertising effectiveness parameters. The square-root specifications ensure diminishing returns to advertising, and hence promote interior solutions for choice of A. Their use is consistent with results from the marketing literature, which suggests on balance a concave response to the rate of advertising (Simon and Arndt; Aaker and Carman). Square-root specifications have also been used in several empirical studies of commodity advertising and found to fit the data well (e.g., Gasmi, Laffont, and Vuong; Alston et al. 1997; Alston et al. 1998). Note that when $A = 0$, the entire market is unbranded and characterized by the total demand depicted in (1). For compactness of notation, we henceforth omit denoting the functional dependence of z and S on A except when it is essential for clarity.

The Two-Stage Game

In stage 2, firm 1 chooses q_B and q_{N_1} to maximize profit in both the branded and nonbranded markets, given the amount expended on advertising in stage 1:

$$\begin{aligned} &\text{Max}\{q_B, q_{N_1}\}\ \Pi_1 = \Pi_B + \Pi_{N_1} = \\ &[P_B(q_B) - W(Q) - c]q_B + [P_N(Q_N) - W(Q) - c]q_{N_1}, \end{aligned} \tag{10}$$

where $Q = q_B + Q_N$, and $Q_N = q_{N_1} + \Sigma_{k=2}^{n} q_{N_k}$.

Given symmetry among the remaining $(n - 1)$ firms, the following first-order conditions are obtained for firm 1:

$$2(1 + \alpha\beta S)q_B^1 + 2\alpha\beta S q_{N_1}^1 + (n - 1)\alpha\beta S q_{N_k}^1 = SX, \tag{10'}$$

$$2\alpha\beta(1 - S)q_B^1 + 2[1 + \alpha\beta(1 - S)]q_{N_1}^1 + (n - 1)[1 + \alpha\beta(1 - S)]q_{N_k}^1 = (1 - S)X, \tag{10''}$$

where superscripts 1 denote the Cournot equilibrium with advertising, $X = a + z - \alpha(b + c) = 1 + z + \alpha\beta$; q_B^1 is firm 1's branded product quantity; $q_{N_1}^1$ is firm 1's nonbranded product quantity; and $q_{N_k}^1$ is firm k's (nonbranded) product quantity ($k = 2, ..., n$).

Firm k's profit-maximization problem is denoted by:

$$\text{Max}\{q_{N_k}\}\ \Pi_k = [P_N(Q_N) - W(Q) - c]q_{N_k}, \quad k = 2, ..., n. \tag{11}$$

Given the symmetry among the $(n - 1)$ firms, we obtain the following first-order condition:

$$\alpha\beta(1 - S)q_B^1 + [1 + \alpha\beta(1 - S)]q_{N_1}^1 + n[1 + \alpha\beta(1 - S)]q_{N_k}^1 = (1 - S)X. \tag{11'}$$

Notice the first-order condition for production of the unbranded product differs for the branded-product firm relative to the other firms. In choosing its level of unbranded production, the branded-product firm takes into account that its production of the unbranded product affects the farm price, which affects the profitability of its sales in both the branded and unbranded market segments. Thus, the branded-product firm always sells less in the unbranded segment than do the other firms.

Equations (10′), (10″), and (11′) describe the market equilibrium and can be rewritten in matrix form as $\mathbf{Bq} = \mathbf{C}$:

$$(12)\quad \begin{bmatrix} 2(1+\alpha\beta S) & 2\alpha\beta S & (n-1)\alpha\beta S \\ 2\alpha\beta(1-S) & 2[1+\alpha\beta(1-S)] & (n-1)[1+\alpha\beta(1-S)] \\ \alpha\beta(1-S) & [1+\alpha\beta(1-S)] & n[1+\alpha\beta(1-S)] \end{bmatrix} \times \begin{bmatrix} q_B^1 \\ q_{N_1}^1 \\ q_{N_k}^1 \end{bmatrix} = \begin{bmatrix} SX \\ (1-S)X \\ (1-S)X \end{bmatrix}.$$

Thus the solution to this system of first-order conditions is $\mathbf{q} = \mathbf{B}^{-1}\mathbf{C}$. By utilizing the normalizations in equations (3) and (4), we obtain:

$$(12')\quad \begin{bmatrix} q_B^1 \\ q_{N_1}^1 \\ q_{N_k}^1 \end{bmatrix} = \frac{X}{\lambda} \begin{bmatrix} (n+1)S[1+(1-S)\phi] \\ (1-S)\{2+\phi[2-(n+1)S]\} \\ 2(1-S)(1+\phi) \end{bmatrix},$$

where $\phi = f\eta/\varepsilon$, $X = 1 + z + \phi$, and $\lambda = 2(n+1)(1+\phi)[1+(1-S)\phi]$; ϕ represents the ratio of retail demand elasticity to farm supply elasticity weighted by the farm share and evaluated at the competitive equilibrium.

The total quantity produced and sold is given by:

$$Q^1 = q_B^1 + q_{N_1}^1 + (n-1)q_{N_k}^1 = q_B^1 + Q_N^1 = \frac{X}{\lambda}\left\{2n[1+\phi(1-S)] - (n-1)S\right\}.$$

The total quantity of the nonbranded product is specified as:

$$Q_N^1 = q_{N_1}^1 + (n-1)q_{N_k}^1 = \frac{X(1-S)}{\lambda}\left[2n(1+\phi) - (n+1)\phi S\right],$$

and the equilibrium prices are:

$$P_N^1 = 1 + \frac{(1+z)(1-S) - Q_N^1}{\eta(1-S)},\quad P_B^1 = 1 + \frac{(1+z)S - q_B^1}{\eta S},\quad W^1 = b + \beta Q^1.$$ [9]

The necessary and sufficient condition for farmers to benefit from a given expenditure on brand advertising is that total sales, Q, expand as a consequence of advertising.[10] We can show $Q^1 > Q^0 = n/(n+1)$ when:

[9] Notice the branded product's share of the total market output (q_B^1/Q^1) will in general not equal its share ($\gamma_1(A)$) of the market demand, because the branded product price is higher than the price for the nonbranded product. Accordingly, $q_B^1/Q^1 < \gamma_1(A)$.

[10] To see this result, note that farm price for any total volume of production is found from the supply curve, $W(Q)$, in (2). Producer welfare can be measured in terms of the producer surplus associated with this supply curve, and thus an increase in output is both necessary and sufficient for producers to benefit from an advertising program.

$$F(A) = z(A) - \frac{(n-1)(1+\phi)S(A)}{2n\{1+\phi[1-S(A)]\} - (n-1)S(A)} > 0, \tag{13}$$

where $z(A)$ and $S(A)$ are defined in (9). The comparative static results are as follows:

$$\frac{\partial F(A)}{\partial n} < 0, \quad \frac{\partial F(A)}{\partial \gamma_0} > 0, \quad \frac{\partial F(A)}{\partial \gamma_1} < 0, \quad \frac{\partial F(A)}{\partial \varepsilon} > 0, \quad \frac{\partial F(A)}{\partial \eta} < 0. \tag{14}$$

From (14), farmers are less likely to benefit from brand advertising the larger is the number of processing firms in the industry. When n is large, the processing industry is relatively competitive. Creation of brand market power in this environment is harmful to farmers relative to a setting when the industry is already highly concentrated, because the degree of market power is already high in the latter case. Not surprisingly, the more effective advertising is at creating brand market power (γ_1), the less likely it is that farmers will benefit from the activity. In contrast, farmers are more likely to benefit the more effective advertising is at shifting total demand (γ_0).

The more elastic the farm supply curve, the larger the quantity increase from a given advertising-induced demand shift, and thus the greater the prospect the equilibrium output with advertising exceeds the no-advertising equilibrium output.[11] Finally, $\partial F(A)/\partial \eta > 0$, because a given shift, $z(A)$, of demand in the quantity direction implies a greater movement along the supply curve, and hence greater price and output effects when demand is relatively inelastic.

In stage 1, firm 1 chooses A to maximize profits given the ensuing behavior in stage 2:

$$\text{Max}\{A\}\ \Pi_1(A) - A = \Pi_B(A) + \Pi_{N_1}(A) - A =$$
$$\frac{X^2}{4\eta(n+1)^2(1+\phi)}\left\{4 + \frac{(n-1)(n+3)S(A)}{1+\phi[1-S(A)]}\right\} - A.$$

The first-order condition leads to the following implicit function, which defines the optimal brand advertising expenditure:

$$4\eta(n+1)^2(1+\phi)\sqrt{A} = \left\{\gamma_0 XG + \frac{\gamma_1(n+3)(n-1)(1+\phi)X^2}{2\left[1+\phi\left(1-\gamma_1\sqrt{A}\right)\right]^2}\right\},$$

where

$$X = 1 + \phi + \gamma_0\sqrt{A} \quad \text{and} \quad G = 4 + \frac{(n+3)(n-1)\gamma_1\sqrt{A}}{1+\phi\left(1-\gamma_1\sqrt{A}\right)}.$$

This market equilibrium is characterized by six parameters: price elasticities of retail demand and farm supply (η and ε) and farmers' share of market revenue ($f = 1 - c$), each evaluated at the competitive equilibrium; the competitive structure of the market, as measured by the number of processing firms (n); and the effectiveness of advertising in shifting demand (γ_0) and in creating brand identity (γ_1). Given values for these parameters, we can solve for firm 1's optimal advertising expenditure, A^*, and for the second-stage outputs, prices, and farmer welfare.

[11] This result must be interpreted carefully. The comparative statics in (14) pertain only to the question of whether farmers will benefit from brand advertising, and do not address the magnitude of benefit. If farmers do benefit from an advertising program, those benefits in general will be greater the more inelastic the farm supply curve.

Equilibrium When the Advertising Firm Is a Cooperative

Now consider the case where the advertising firm is a farmer-owned cooperative. All else is unchanged from the preceding model. We assume throughout that the cooperative has a closed membership.[12] The cooperative at the outset has $1/n$ of the farmers and pursues the objective of maximizing its members' welfare as farmers and joint owners of the cooperative processing firm.

To provide a benchmark for comparison, we first study the n-firm Cournot equilibrium in the absence of any brand advertising, when one of the firms is a cooperative. This solution is not the same as the n-firm Cournot equilibrium in the preceding model because the cooperative does not exercise oligopsony power in dealing with its members, and thus produces more than a comparable investor-owned firm (IOF). Therefore, even in the absence of brand advertising, the equilibrium is not symmetric and, accordingly, the mathematical characterization of the solution is rather cumbersome. We therefore relegate the formal derivation of the market equilibrium, both with and without brand advertising, to appendix A. Although the expressions characterizing the market equilibrium in the presence of a cooperative differ from the equilibria when all firms are IOFs, the equilibrium is still characterized by the same six parameters: η, ε, f, n, γ_0, and γ_1.

A cooperative that engages in an optimal brand-advertising program must provide a net benefit to its membership from the expenditure, because it could always elect to set advertising expenditures to zero and produce exclusively in the unbranded segment of the market. Consequently, the important questions concerning advertising by a cooperative are (*a*) its impact on farmers who sell to the IOF processors, and (*b*) its impact on farmers in aggregate.

Farmers who sell to the IOF processors will benefit from demand expansion created by the cooperative, but will be harmed by the expansion of the cooperative's market share, and thus the reduction of share accruing to the IOF processors. Farmers selling to the IOF processors benefit from advertising by the cooperative only if their total sales expand as a consequence.

Unlike the market with only IOF processors, farmers in aggregate (i.e., both members and nonmembers of the cooperative) may benefit from a brand-advertising program even if total sales decline, because the members of the cooperative capture all of the benefits from the cooperative's advertising. In other words, the net price received by members of the cooperative is not determined simply from their supply curve, as is true for all farmers when all handlers in the market are IOFs. Thus, expansion of total sales is not a necessary condition for farmers as a group to benefit from the brand-advertising program, as was true when all processors were IOFs (see footnote 10), although it is a sufficient condition.

[12] Closed membership, i.e., the cooperative does not accept new members, is common in settings where the cooperative has a strong brand label. An open membership would be inconsistent with the goal of creating brand market power through advertising. In particular, if advertising succeeded in raising profit to the cooperatives' members relative to the profit earned by other farmers, then outsiders would enter the cooperative until, at the margin, returns were equalized between members and nonmembers of the cooperative. Effectively, an open membership policy would enable outsiders to free ride on investments in advertising by a cooperative.

Simulation Analysis

Because the analytical solutions to the two-stage model are rather complex for both cases, we used simulation analysis to further investigate the impact of brand advertising on farmer welfare. Farmer welfare was measured in terms of producer surplus (*PS*), and *PS* was compared in the equilibria with and without brand advertising. Using the 0 and 1 superscripts to denote, respectively, the equilibrium without and with brand advertising, we have the following specifications for farmer welfare, given the supply curve indicated in (2):

$$PS^{\tau} = \int_{b}^{W^{\tau}} \frac{W - b}{\beta}\, dW = \frac{(W^{\tau} - b)^2}{2\beta}, \quad \tau = 0, 1. \tag{15}$$

The change in farmers' surplus due to brand advertising is written as:

$$\Delta PS = PS^1 - PS^0. \tag{16}$$

To construct the simulation, we needed to generate a range of reasonable values for the six parameters that define the market equilibrium. Consider first the parameter γ_0, to measure the effectiveness of brand advertising in expanding total demand. Given the linear formulation of market demand and the square-root specification for advertising's impact on demand, γ_0 can be linked to the elasticity of demand with respect to advertising, μ, as follows:

$$\mu = (\partial Q/\partial A)(A/Q) = \left(\gamma_0\sqrt{A}\,\right)/2Q. \tag{17}$$

As noted in the introduction, only a few studies have evaluated the effectiveness of brand advertising in increasing demand in a commodity market setting, thus leaving us with little information as to a plausible range of values for μ. The empirical work conducted on the demand-shift effects of brand advertising suggests its effectiveness may be similar to comparable generic advertising programs, which have been studied extensively (for summaries of this work, see Forker and Ward; Ferraro et al.). Thus, we relied on the results from the generic advertising literature to establish $\mu \in [0.01, 0.05]$ as a range of plausible values to consider in the simulation. The base values for the elasticity μ were then converted to their equivalent underlying slope parameter, γ_0, as described in appendix B. Given γ_0 derived in this manner, the parameter γ_1 to measure the effectiveness of advertising at creating brand market power was set simply as $\gamma_1 = k\gamma_0$, where k measures the relative effectiveness of advertising at creating brand market share versus expanding total market demand. Finally, in all cases, we fixed the farm share parameter at $f = 1 - c = 0.5$, and the farm supply and retail demand price elasticities at $\varepsilon = \eta = 1.0$ (all evaluated at the competitive market equilibrium).[13]

[13] A farm revenue share of 0.5 under perfect competition is roughly consistent with the farm share for meats, eggs, and dairy products. The supply elasticity is not an important parameter is this analysis—as supply becomes more elastic, the change in producer surplus from advertising decreases under all sets of market conditions. The effect of the price elasticity of demand, however, is more complicated because it affects both the branded-product firm's incentives to advertise and, given the level of advertising expenditure in stage 1, its impact on equilibrium price and output in stage 2. From the advertising firm's perspective, the incentive to advertise is greater the more inelastic is the demand curve, because inelastic demand translates a demand shift from advertising into mostly a price (versus a quantity) impact. However, farmers benefit from the advertising only to the extent that it expands market output. Thus, for any combination of the other market parameters, the effect on farmer surplus, whether positive or negative, is magnified the more elastic is the underlying market demand, because the quantity impact, whether positive or negative, is magnified.

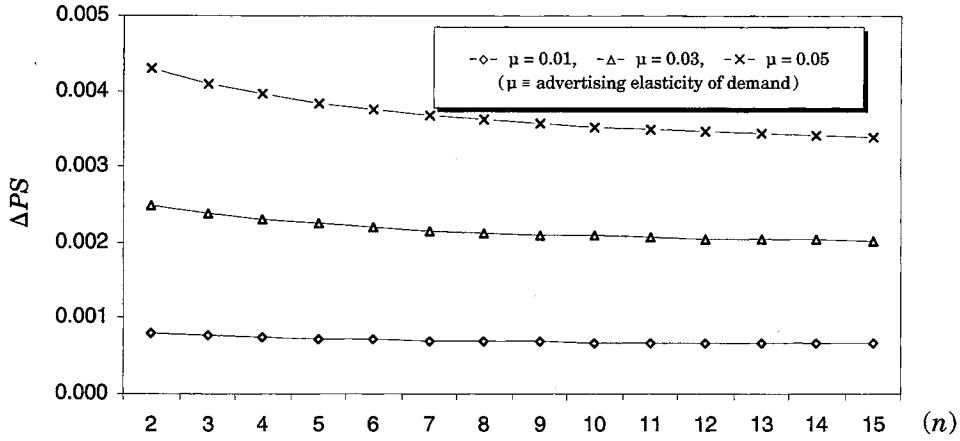
Figures 1 and 2 summarize the simulation results for the model where the advertising firm is an IOF. In all cases, we examine the change in producer surplus, ΔPS, resulting from the introduction of brand advertising. Figure 1 examines the effect on ΔPS of concentration in the processing sector, as measured by the number of marketing firms n. Each panel in figure 1 features a different choice of k, the relative advertising effectiveness parameter. Figure 2 examines the effect of k on ΔPS, with each panel in figure 2 depicting an alternative choice of n. The curves in both figures depict ΔPS for a particular value for the advertising elasticity of demand, μ (0.01, 0.03, 0.05), and thus γ_0, based on the procedure described in appendix B.

Figure 1 illustrates the comparative static result that brand advertising is less likely to yield benefits to farmers when the processing industry is relatively unconcentrated, i.e., the market is relatively competitive in the absence of brand differentiation. Large values of n imply only limited oligopoly-oligopsony power in the Cournot equilibrium and, accordingly, high levels of farmers' producer surplus. Creation of monopoly power through brand advertising therefore has an important adverse effect on farmer welfare. When k is small, so that advertising is only moderately effective at creating brand identity relative to expanding total demand (panel A), farmers benefit from brand advertising for all values of n, although the magnitude of benefit is decreasing in n. However, for larger values of k, farmers' welfare declines from brand advertising when the processing industry is rather unconcentrated (i.e., when n is large). For example, in panel C, when $k = 2.5$, farmer welfare declines under any of the advertising demand elasticity specifications for all $n > 4$.

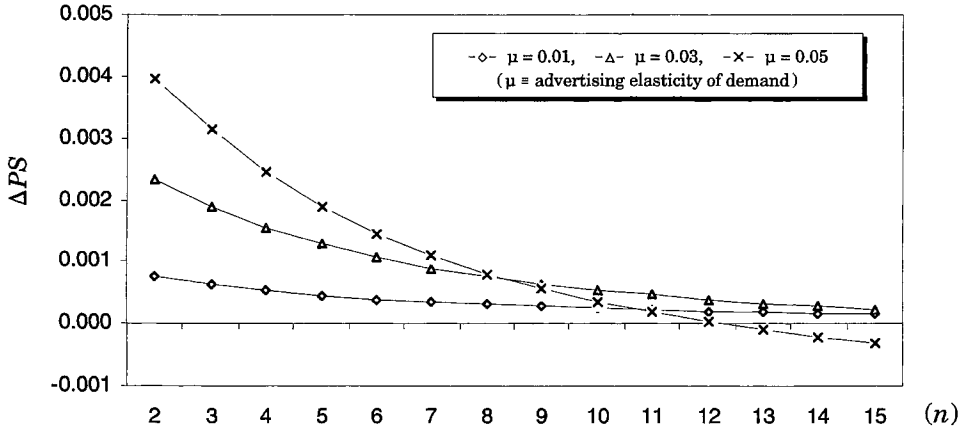
The interaction of the advertising elasticity of demand (μ) with the other market parameters is interesting. When k is small, as in panel A of figure 1, the benefit to farmers is greater for larger values of μ, which in turn implies larger values for γ_0, for all values of n. In this setting, the brand market-power effect of advertising is weak relative to its demand-shift effect, and thus larger values of μ and γ_0 are beneficial from farmers' perspective because the associated advertising expenditure is higher. However, as the brand market-power impact of advertising increases in panels B and C, farmer welfare may be decreasing as a function of μ, especially for larger values of n. In these settings, larger values of μ inspire a larger level of expenditures from the advertising firm, but these expenditures are harmful to farmer welfare when their primary effect is to create brand market power.

In figure 2, higher values of k represent advertising which is increasingly effective at creating brand market power for the advertising firm relative to increasing total demand. Accordingly, the firm's optimal advertising expenditure is increasing in k. For small values of k, the demand-expanding effect of increased advertising dominates the market-power effect, and farmer welfare is increasing in k. When n is small, such as $n = 2$ in panel A, farmers benefit for all values of k and μ included in figure 2. In this setting, the market is a highly concentrated duopoly-duopsony in the absence of brand advertising, so the incremental market power created by advertising is small and is dominated by the demand-expansion effect. However, for the larger values of n depicted in panels B and C, the market-power effect from increasing k comes to dominate the demand-expansion effect, causing farmer welfare to decline for large k. The effect, whether positive or negative, is magnified the greater is the overall effectiveness of advertising, as measured by μ.

PANEL A. $k = 1.5$ (low brand power effect relative to demand expansion)



PANEL B. $k = 2$ (intermediate brand power effect relative to demand expansion)



PANEL C. $k = 2.5$ (high brand power effect relative to demand expansion)

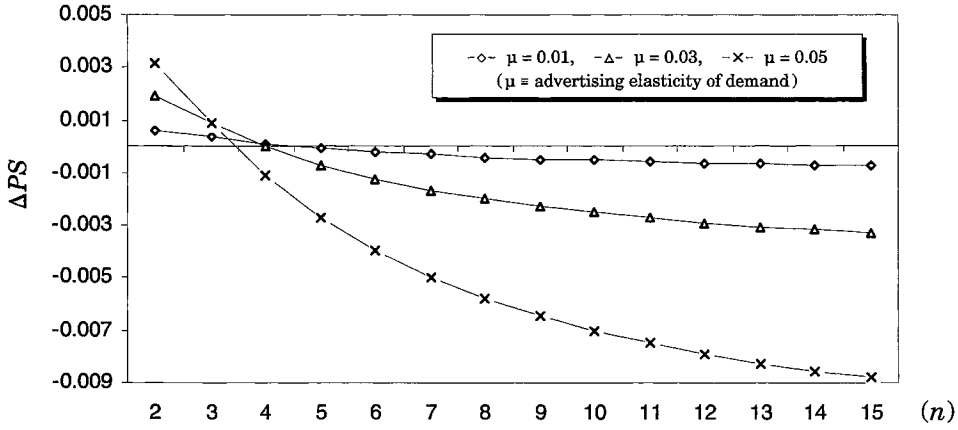


Figure 1. Farmer welfare in investor-owned firm model as a function of number of processors, *n*

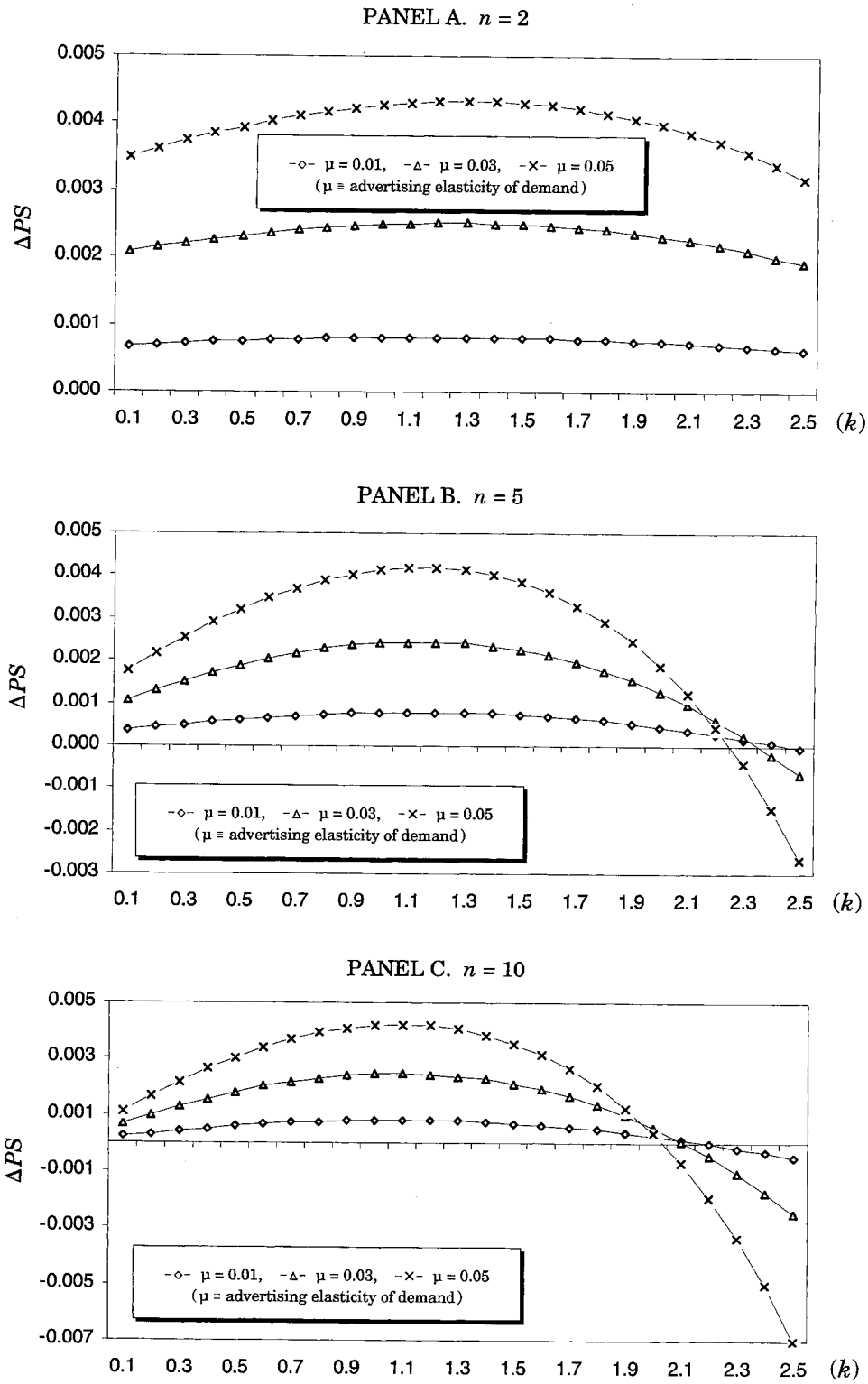


Figure 2. Farmer welfare in investor-owned firm model as a function of brand advertising effectiveness, *k*

Table 1 reports equilibrium values for the key market variables for selected simulations when the advertising firm is an IOF, including branded, unbranded, and farm price, advertising-to-sales (*A/S*) ratio, and the percentage change in output and producer surplus due to advertising. To conserve space, table 1 gives results only for $n = 2, 4, 8$, and 12. One test of the realism of the simulation is to examine the equilibrium outcomes for key market variables, such as the advertising-to-sales ratio and the branded-to-unbranded price ratio.

The expenditure on brand advertising as a percentage of total industry sales (*A/S*) in the simulation ranges from a low of 0.15% when $\mu = 0.01$ and $k = 1.5$ (i.e., the advertising elasticity of demand is small and the brand-share effect is weak) to a high of 3.9% when $\mu = 0.05$ and $k = 2.5$ (i.e., the advertising elasticity of demand is large and the brand-share effect is strong). These values compare quite closely to industry advertising-to-sales ratios for 1992 (the most recent year available) for four-digit Standard Industrial Classification (SIC) food product categories where there is a clearly identifiable primary agricultural product: 2011, meat packing plant products = 0.35%; 2022, natural and processed cheese = 0.55%; 2026, fluid milk = 0.25%; 2033, canned fruits and vegetables = 1.72%; 2084, wines, brandy, and brandy spirits = 2.38%; and 2096, potato chips and similar products = 1.70%.[14]

In the absence of advertising, the output market price is 1.333, 1.200, 1.111, and 1.077 for $n = 2, 4, 8$, and 12, respectively [see equation (6)]. The impact on the unbranded product price from brand advertising is ambiguous because the demand-shift and brand-share effects have offsetting effects on the unbranded segment of the market. However, in the simulations reported in table 1, the unbranded price increases, albeit slightly, in all instances except the case when $n = 12$, $k = 2.5$, and $\mu = 0.05$. The branded price fluctuates within a relatively narrow band, from 1.50 to 1.56 for all parameter values. Thus, price premiums in the simulation for the branded product range from 13.6% to 45.1%.

These numbers, too, comport closely to actual price premiums observed for branded products. For example, using 1989 data, Cotterill and Haller reported a branded/private-label price ratio of 1.11 for fluid milk (Land O' Lakes), 1.16 for butter (Land O' Lakes), and 1.70 for ice cream (various Philip Morris brands); Franklin and Cotterill found a branded/private-label price ratio of 1.38 for natural cheese (Kraft); and Wills and Mueller reported an average 18% price premium for branded products relative to private labels across 133 food product categories included in their study.

We also used simulations to study the impact of brand advertising by a cooperative. As noted, it is necessary to distinguish advertising's effects on the farmers who are members of the co-op from its effects on the nonmember farmers who patronize the $n - 1$ IOFs. Thus, in figures 3 and 4, we depict the change in welfare as a result of advertising for the co-op members, the nonmember farmers, and farmers in total. To simplify the presentation, μ is fixed at its intermediate value ($\mu = 0.03$) in all instances.

Because the cooperative is assumed to choose its advertising expenditure to maximize member welfare, a positive optimal advertising expenditure by a cooperative will always benefit its farmer members. Thus, for the co-op members, $\Delta PS > 0$ in all panels of figures 3 and 4.

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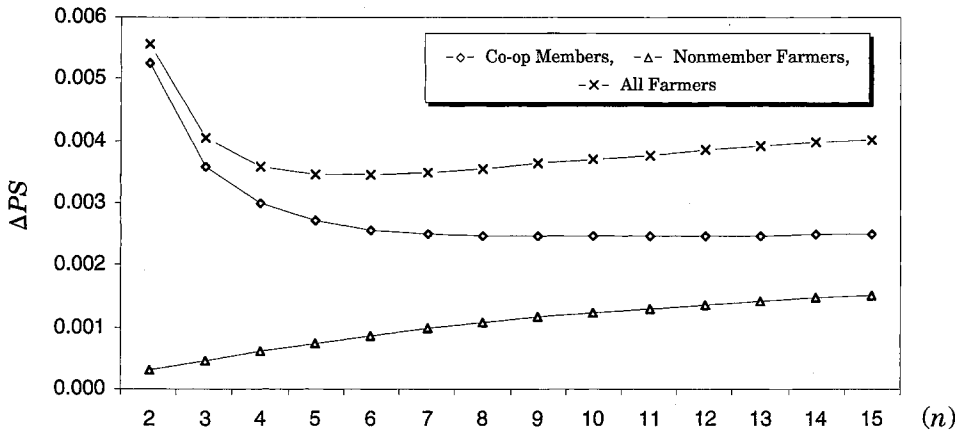
[14] These data were obtained from the NE-165 project database, managed by Richard Rogers of the University of Massachusetts.

Table 1. Selected Simulation Results for the Investor-Owned Firm Model

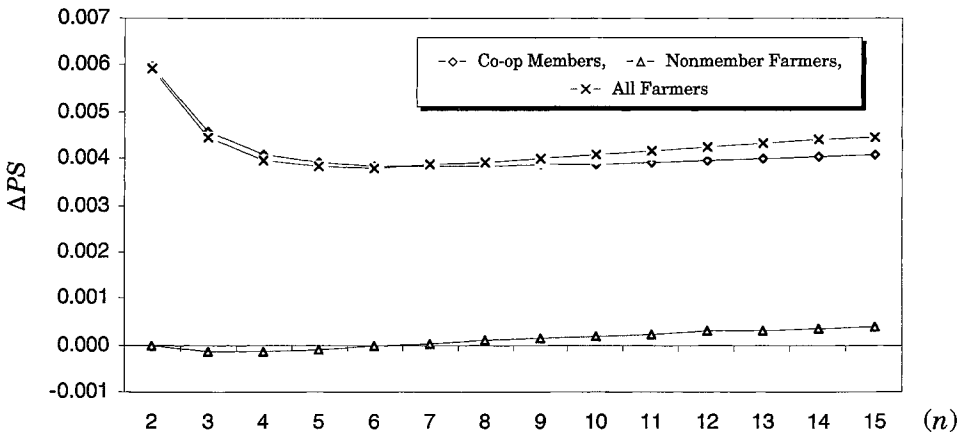
n	μ	$\%\Delta Q$	$\%\Delta PS$	P_N	P_B	W_1	A/S
k = 1.5:							
2	0.01	0.36	0.73	1.338	1.506	0.335	0.0021
4	0.01	0.23	0.47	1.203	1.505	0.401	0.0017
8	0.01	0.18	0.35	1.113	1.505	0.445	0.0015
12	0.01	0.16	0.32	1.078	1.505	0.462	0.0015
2	0.03	1.12	2.25	1.346	1.518	0.337	0.0069
4	0.03	0.72	1.44	1.208	1.517	0.403	0.0056
8	0.03	0.54	1.08	1.116	1.517	0.447	0.0051
12	0.03	0.48	0.97	1.081	1.517	0.464	0.0050
2	0.05	1.92	3.87	1.356	1.532	0.340	0.0122
4	0.05	1.22	2.47	1.214	1.530	0.405	0.0103
8	0.05	0.91	1.83	1.120	1.530	0.449	0.0096
12	0.05	0.81	1.63	1.084	1.529	0.465	0.0095
k = 2.0:							
2	0.01	0.34	0.68	1.338	1.507	0.335	0.0039
4	0.01	0.17	0.33	1.203	1.507	0.401	0.0028
8	0.01	0.08	0.16	1.113	1.507	0.445	0.0027
12	0.01	0.05	0.10	1.078	1.507	0.462	0.0027
2	0.03	1.04	2.09	1.348	1.522	0.337	0.0097
4	0.03	0.48	0.97	1.209	1.522	0.402	0.0096
8	0.03	0.19	0.38	1.116	1.523	0.445	0.0096
12	0.03	0.09	0.19	1.080	1.523	0.462	0.0096
2	0.05	1.77	3.58	1.359	1.539	0.339	0.0179
4	0.05	0.76	1.53	1.215	1.541	0.403	0.0189
8	0.05	0.20	0.41	1.119	1.542	0.445	0.0195
12	0.05	0.01	0.02	1.082	1.542	0.462	0.0196
k = 2.5:							
2	0.01	0.29	0.57	1.338	1.508	0.334	0.0039
4	0.01	0.04	0.08	1.203	1.509	0.400	0.0042
8	0.01	-0.10	-0.20	1.112	1.509	0.444	0.0043
12	0.01	-0.15	-0.30	1.077	1.509	0.461	0.0043
2	0.03	0.86	1.73	1.349	1.525	0.336	0.0133
4	0.03	0.00	0.00	1.209	1.528	0.400	0.0154
8	0.03	-0.50	-1.01	1.114	1.530	0.442	0.0163
12	0.03	-0.78	-1.35	1.077	1.530	0.458	0.0167
2	0.05	1.42	2.86	1.361	1.547	0.338	0.0259
4	0.05	-0.34	-0.68	1.215	1.555	0.399	0.0337
8	0.05	-1.47	-2.92	1.114	1.559	0.438	0.0378
12	0.05	-1.87	-3.70	1.075	1.560	0.453	0.0390

Notes: n = number of processing firms, k = brand advertising effectiveness, μ = advertising elasticity of demand, ΔQ = change in industry output, ΔPS = change in producer surplus, P_N = price of nonbranded product, P_B = price of branded product, W_1 = farm price, and A/S = advertising-to-sales ratio.

PANEL A. k = 1.2 (low brand power effect relative to demand expansion)



PANEL B. k = 1.6 (intermediate brand power effect relative to demand expansion)



PANEL C. k = 2 (high brand power effect relative to demand expansion)

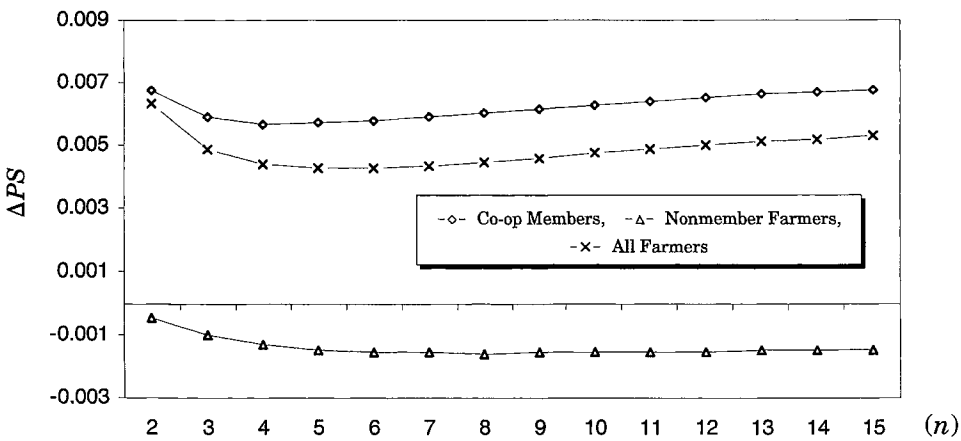


Figure 3. Farmer welfare in the cooperative model as a function of number of processors, *n*

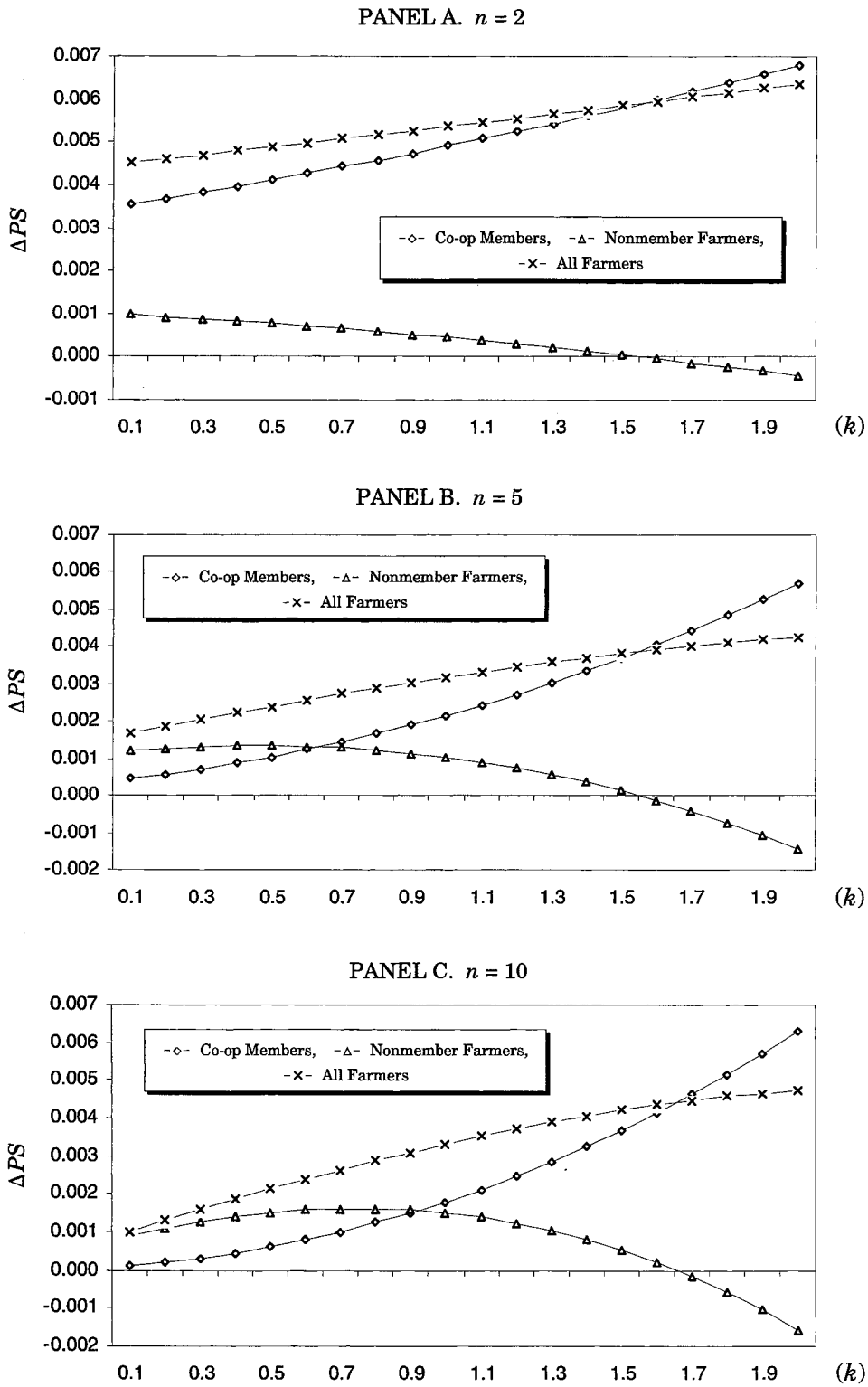


Figure 4. Farmer welfare in the cooperative model as a function of brand advertising effectiveness, *k*

The effect of the market structure, measured by n, on benefits to members from a cooperative's advertising is notable. Market concentration tends to be beneficial to members of a cooperative, because as owners of the cooperative, they do not face oligopsony power and they capture the oligopoly profits earned by the cooperative.

Two factors are at work in determining the effect of n on benefits to a cooperative's members from brand advertising. First, larger n implies low extant market power in the no-advertising equilibrium, so brand market power creates a benefit to members that is largely absent in the no-advertising equilibrium. However, larger n also means a larger spillover effect to outsiders from the demand-shift effect of advertising. Thus, in all three panels of figure 3, members' change in producer surplus is a U-shaped function of n. When n is small, the spillover effect from increasing n dominates the market-power effect, and ΔPS is decreasing in n for co-op members. For larger n, the relative effects are reversed, and ΔPS rises as a function of n for the co-op members.

Successful brand promotion by the cooperative firm expands its total share of the market, resulting in a lower cumulative market share for the $n - 1$ IOFs. Thus, for large values of k—i.e., the advertising is relatively more effective at expanding brand share than total market demand—the farmers who patronize the IOFs may lose surplus as a result of the cooperative's brand advertising. For example, in figure 3, panel C, when $k = 2$, the nonmember farmers lose for all values of $n \geq 2$. Similarly, figure 4 shows the nonmember farmers losing for larger values of k regardless of the choices of n. However, over the range of parameters simulated in figures 3 and 4, the benefits to the co-op members always exceed the losses, if any, to nonmembers, and therefore total producer surplus always increases when the brand advertising is conducted by a cooperative firm.[15]

Conclusion

Although the topic of brand advertising in the food sector and its effect on market structure and performance has been studied extensively, the focus to date has been on the consumer welfare impacts associated with advertising-induced increases in market power. In this analysis, the neglected issue of brand advertising's effects on farmer welfare is studied. We identified two offsetting impacts. First, brand advertising may increase total demand for the farm product, and second, brand advertising may increase the market power of the advertising firm, leading to a reduction in total sales and thus a reduction in farmer welfare. A further crucial issue is whether the advertising is conducted by a cooperative, so that the farmer-members receive the benefit of any brand market power created, or by an investor-owned firm.

Brand advertising by an investor-owned firm is most likely harmful to farmers when it takes place in a relatively unconcentrated industry and when the advertising is relatively more effective at creating brand power than at increasing total demand. Members of a cooperative will always benefit from an optimal expenditure on brand advertising by their cooperative. However, farmers who are not members of the advertising cooperative may be harmed.

[15] Although this result is true across the various simulations conducted, given the large number of parameters in the model, it is not possible to perform exhaustive simulations, and therefore we cannot be certain this result holds for all reasonable parameter combinations.

Brand advertising in agricultural commodity markets is an issue likely to increase in prominence in the United States in light of increasing consolidation in the marketing sector and the Supreme Court's decision in the *United Foods* case. The argument made by shippers and handlers, such as United Foods, in the discussions surrounding commodity promotion programs, is that they could do better using advertising money to promote their own products rather than contributing funds to support a generic program (Crespi and Sexton). Although this argument may be correct, this analysis demonstrates that expenditures to promote a brand may be harmful to farmers' interests.

One possible response of commodity promotion programs to the *United Foods* decision is to allow marketer/handlers to promote their own products in lieu of contributing to a generic promotion program. Because of the offsetting effects of brand advertising on farmer welfare, the question of whether brand advertising should be supported through commodity check-off programs must be resolved on a case-by-case basis.

Although the demand-expanding effects of generic versus brand advertising expenditures probably can be estimated econometrically (e.g., Hall and Foik; Kaiser), the market power impacts of brand advertising are likely much more difficult to estimate because the necessary firm-level data are generally confidential and the effects of advertising on market power may be difficult to disentangle from the various other factors that might influence it. In programs where the goal is advancement of farmer welfare, the existence of market-power effects implies that a necessary (though not sufficient) condition to commodity promotion funds to be used in support of brand advertising in lieu of generic advertising is: brand advertising's marginal impact on demand must exceed the marginal impact of generic advertising expenditures.

Given the simplified structure of the model developed in this study, several extensions and generalizations present themselves as topics for future research. Notable among them include allowing for environments where more than one firm might advertise, incorporating explicit substitution between branded and unbranded products, and, in addition to producer impacts, also considering consumer and social welfare impacts of advertising programs.

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Appendix A: Equilibrium When the Advertising Firm Is a Cooperative

The total market demand is defined as in text equation (1). The cooperative has as members $1/n$ of the total number of identical farmers. The inverse raw product supply to firm 1 (the cooperative) is:

$$W = b + n\beta q_1, \tag{A1}$$

and the inverse raw product supply to the remaining $n - 1$ firms is:

$$W = b + \frac{n}{n-1}\beta Q_{-1}, \tag{A2}$$

where

$$Q_{-1} = \sum_{k=2}^{n} q_k.$$

Equilibrium Without Brand Advertising

The cooperative maximizes member welfare, which is sales revenue minus processing and farm production costs:

$$\text{Max}\{q_1\}\ \Pi_1 = [P(Q) - c]q_1 - \int_0^{q_1}(b + n\beta q)\,dq = \left[P(Q) - c - b - \frac{n\beta}{2}q_1\right]q_1, \tag{A3}$$

where $Q = q_1 + Q_{-1}$. Differentiating equation (A3) with respect to q_1 and imposing symmetry among the remaining $n - 1$ firms, we obtain the following first-order condition:

$$(2 + n\alpha\beta)q_1 + (n - 1)q_k = a - \alpha(b + c). \tag{A4}$$

For the remaining $(n - 1)$ firms, a representative firm k's objective is to:

$$\text{Max}\{q_k\}\ \Pi_k = [P(Q) - W(Q_{-1}) - c]q_k, \quad k = 2, \ldots, n. \tag{A5}$$

The first-order condition to equation (A5) yields:

$$(n-1)q_1 + n(n-1+n\alpha\beta)q_k = [a - \alpha(b+c)](n-1). \tag{A6}$$

Solving (A4) and (A6) simultaneously and using the same normalizations as in the model with all IOF processors, we obtain:

$$q_1^0 = \frac{(n-1+n^2\phi)X_0}{\lambda_0}, \quad q_k^0 = \frac{(n-1)(1+n\phi)X_0}{\lambda_0}, \quad k = 2, \ldots, n,$$

where $X_0 = 1 + \phi$, and $\lambda_0 = n^2 - 1 + n^2(1 + n + n\phi)\phi$.

Note that $q_1^0 > q_k^0$ because the cooperative doesn't exercise oligopsony power in dealing with its members. The total sales volume (Q^0) and the total sales (Q_{n-1}^0), excluding firm 1, are:

$$Q^0 = q_1^0 + (n-1)q_k^0 = \frac{n[n-1+\phi(1-n+n^2)]X_0}{\lambda_0}, \quad Q_{n-1}^0 = (n-1)q_k^0 = \frac{(n-1)^2(1+n\phi)X_0}{\lambda_0}.$$

The total production Q^0 at the Cournot equilibrium without advertising in this model is greater than in the model with all IOF processors due to the presence of the cooperative.

The Two-Stage Game

We now consider competition when the cooperative (firm 1) sells both a branded and an unbranded product. In stage 2, the cooperative chooses q_B and q_{N_1} to maximize member welfare in both the branded and nonbranded markets:

$$\begin{aligned}\text{Max}\{q_B, q_{N_1}\} &= [P_B(q_B) - c]q_B + [P_N(Q_N) - c]q_{N_1} - \int_0^{q_B+q_{N_1}} (b + n\beta q)\,dq \\ &= [P_B(q_B) - c]q_B + [P_N(Q_N) - c]q_{N_1} - (q_B + q_{N_1})\left[b + \frac{n\beta}{2}(q_B + q_{N_1})\right],\end{aligned}$$

where $Q_N = q_{N_1} + Q_{-1}$. The first-order conditions yield:

$$[2 + nS\alpha\beta]q_B + nS\alpha\beta q_{N_1} = SX, \tag{A7}$$

$$n(1-S)\alpha\beta q_B + [2 + n(1-S)\alpha\beta]q_{N_1} + (n-1)q_{N_k} = (1-S)X. \tag{A8}$$

Firm k's profit-maximization problem is given as:

$$\text{Max}\{q_{N_k}\}\ \Pi_k = [P_N(Q_N) - W(Q_{-1}) - c]q_{N_k}, \quad k = 2, \ldots, n;$$

the first-order condition is:

$$(n-1)q_{N_1} + n[n-1+n(1-S)\alpha\beta]q_{N_k} = (n-1)(1-S)X. \tag{A9}$$

By rearranging (A7), (A8), and (A9), we obtain the following system of first-order conditions:

$$\begin{bmatrix} 2 + nS\alpha\beta & nS\alpha\beta & 0 \\ n(1-S)\alpha\beta & 2 + n(1-S)\alpha\beta & n-1 \\ 0 & n-1 & n[n-1+n(1-S)\alpha\beta] \end{bmatrix} \times \begin{bmatrix} q_B^1 \\ q_{N_1}^1 \\ q_{N_k}^1 \end{bmatrix} = \begin{bmatrix} SX \\ (1-S)X \\ (n-1)(1-S)X \end{bmatrix}.$$

This system of equations can be rewritten as $\mathbf{Bq} = \mathbf{C}$, and thus $\mathbf{q} = \mathbf{B}^{-1}\mathbf{C}$:

$$\begin{bmatrix} q_B^1 \\ q_{N_1}^1 \\ q_{N_k}^1 \end{bmatrix} = \frac{X}{\lambda_2}\begin{bmatrix} SD \\ (1-S)E \\ (1-S)F \end{bmatrix},$$

where

$$\lambda_2 = 2n(2 + n\phi)[n - 1 + n(1 - S)\phi] - (n - 1)^2(2 + nS\phi),$$
$$D = n^2 - 1 + n(n^2 + 1)(1 - S)\phi,$$
$$E = 2(n - 1) + 2n^2\phi - n(n^2 + 1)S\phi,$$
$$F = 2(n - 1)(1 + n\phi).$$

Thus the total quantities produced and sold are, respectively:

$$Q^1 = q_B^1 + q_{N_1}^1 + (n - 1)q_{N_k}^1 = \frac{X}{\lambda_2}\left[2n(n^2 - n + 1)(1 - S)\phi + (n - 1)\left[2n - (n - 1)S\right]\right],$$

$$Q_N^1 = q_{N_1}^1 + (n - 1)q_{N_k}^1 = \frac{X(1 - S)}{\lambda_2}\left[2n(n - 1) + 2n(n^2 - n + 1)\phi - (n^2 + 1)nS\phi\right].$$

In stage 1, the cooperative firm chooses A to maximize member welfare given the ensuing behavior in stage 2:

(A10)
$$\text{Max}\{A\}\ [P_B - c]q_B + [P_N - c]q_{N_1} - (q_B + q_{N_1})\left[b + \frac{n\beta}{2}(q_B + q_{N_1})\right] - A$$
$$= \frac{X^2}{2\eta\lambda_2^2}\left\{2SD(\lambda_2 - D) + 2(1 - S)E(\lambda_2 - H) - n\phi[SD + (1 - S)E]^2\right\} - A,$$

where $H = E + (n - 1)F$. Let $Y = 2SD(\lambda_2 - D) + 2(1 - S)E(\lambda_2 - H) - n\phi[SD + (1 - S)E]^2$. The first-order condition to (A10) leads to the following implicit function:

(A11)
$$2XY\lambda_2 X' + X^2\lambda_2 Y' - 2X^2 Y\lambda_2' = 2\eta\lambda_2^3,$$

where

$$X' = \frac{\gamma_0}{2\sqrt{A}},$$
$$Y' = 2(S'D + SD')(\lambda_2 - D) + 2SD(\lambda_2' - D') + 2[(1 - S)E' - S'E](\lambda_2 - H)$$
$$+ 2(1 - S)E(\lambda_2' - E') - 2n\phi[SD + (1 - S)E](S'D - S'E + E'),$$
$$\lambda_2' = -n\phi[(n - 1)^2 + 2n(2 + n\phi)]S',$$
$$S' = \frac{\gamma_1}{2\sqrt{A}},$$
$$D' = E' = H' = -(n^2 + 1)n\phi S'.$$

This model is characterized by the same six parameters as model 1: price elasticities of demand (η) and supply (ε), farmers' share of final product revenue (f), number of processing firms (n), and the effectiveness of advertising in shifting demand (γ_0) and creating brand identity (γ_1). Given values for these parameters, we can solve for the cooperative's optimal advertising expenditure A^*, and for the second-stage outputs, prices, and farmer welfare.

Appendix B: Deriving the Advertising Demand-Shift Parameter, γ_0

Advertising funds for generic programs are usually generated from per unit tax or "check-off" programs, so $A = tQ$, where t is the tax rate. Substituting this expression for A in text equation (17) yields:

(B1)
$$\mu = (\gamma_0/2)\sqrt{t/Q}\ .$$

The goal is to utilize (B1) to express γ_0 in terms of μ and the other parameters that define the market equilibrium. Thus, the endogenous variables t and Q need to be solved and expressed as functions of the market parameters. Using the same linear model structure as employed in this study, Zhang and

Sexton recently analyzed the behavior of a commodity board which selects t to maximize producer surplus, given retail demand, farm supply, and processor/retailer cost functions, as well as the form of competition governing the interactions between farmers and processor/retailers and between processor/retailers and consumers.

Consistent with the decision to normalize the other market parameters at the competitive equilibrium, we solve for the optimal tax rate (t^*) and the equilibrium output (Q^*), assuming perfect competition in the downstream markets, in which case we have $t^* = t^*(\varepsilon, \eta, f)$ and $Q^* = Q^*(\varepsilon, \eta, f)$. These expressions can then be substituted into (B1), and (B1) can be solved for $\gamma_0 = \gamma_0(\mu, \varepsilon, \eta, f)$. In this manner, the advertising effectiveness parameter can be expressed in terms of values for the advertising elasticity of demand based on the empirical literature, and values chosen in the simulation for the farm price elasticity of supply, retail price elasticity of demand, and farm share of market revenue. The technical details on deriving t^* and Q^* are available in Zhang and Sexton.