How Does Advertising Affect Market Performance? The Case of Generic Advertising

By

Stephen F. Hamilton
Orfalea College of Business
Cal Poly San Luis Obispo

Timothy J. Richards
Morrison School of Management and Agribusiness,
Arizona State University

and

Kyle W. Stiegert
Department of Agricultural and Applied Economics
University of Wisconsin-Madison

Selected Paper prepared for presentation at the Agricultural & Applied Economics Association 2009 AAEA & ACCI Joint Annual Meeting, Milwaukee, Wisconsin, July 26-29, 2009

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Stephen F. Hamilton*
Cal Poly San Luis Obispo

Timothy J. Richards
Arizona State University

Kyle W. Stiegert
University of Wisconsin-Madison

April 24, 2009

Abstract

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JEL classification: L1, M37
Key words: Advertising, Oligopoly

*Correspondence to: S. Hamilton, Department of Economics, Orfalea College of Business, Cal Poly, San Luis Obispo, CA 93407. Voice: (805) 756-2555, Fax: (805) 756-1473, email: shamilto@calpoly.edu. We thank Bill Greene, Glenn Harrison, Robert Innes, and Dave Sunding for helpful comments on an earlier draft. Financial support from the FSRG at the University of Wisconsin-Madison is gratefully acknowledged.

1 Introduction

A long-standing debate in the economics of advertising is the effect of advertising on market performance.[1] One school of thought, articulated in the contributions of Kaldor (1950) and Bain (1956), advocates that advertising serves primarily a persuasive role. According to this view, advertising increases product differentiation and deters entry by contributing recognition and prestige to advertised goods, thereby inflating the market power of firms selling advertised goods and bracing prices. A second school of thought, formalized by Ozga (1960), Stigler (1961), Telser (1964) and Nelson (1970, 1974), points to the important role of advertising in providing price and product quality information. Informative advertising reduces the costs associated with consumer search and facilitates substitution possibilities between products, resulting in lower prices and superior market performance.

In this Journal, Becker and Murphy (1993) present a theory of advertising as a complementary product to advertised goods. This "complementary view" is sufficiently general to allow advertising to provide private consumption values (e.g., advertisements in the Yellow Pages), public good values (e.g., "social status" emerging in equilibrium through an element of collective persuasion), or joint consumption value with media goods (e.g., advertising bundled and "sold" together with television programming).[2] The sensible conclusion emerging from this view is that understanding the welfare effects of advertising requires looking at advertising markets in addition to the markets for advertised goods. Nevertheless, it is clear that encompassing a complementary advertising "good" in individual utility functions does little to resolve how advertising alters the market performance of advertised goods.

We propose a novel revealed preference approach to assess how advertising alters the performance of markets for advertised goods. We frame our analysis around a homogeneous product oligopoly market with asymmetric factor endowments among

[1] For an excellent review, see Bagwell (2005).

[2] This view represents a fundamental departure from Kaldor (1950), who regarded advertising as a non-priced commodity sold jointly with advertised goods.

firms, and propel our study by formulating a few simple observations on how changes in the dispersion of consumers' valuations for an advertised good redistribute rents among producers in the market. Specifically, we consider generic advertising programs funded through per-unit levies on output and show that advertising messages that increase (decrease) the dispersion of consumers' valuations allocate a disproportionate share of advertising rents to producers with smaller (larger) factor endowments.

Generic advertising programs funded through so-called "checkoff fees" are commonly employed for commodity promotion in the United States under the Agricultural Marketing Agreement Act of 1937. These cooperative arrangements provide a useful lens to examine the effect of advertising on market performance since they allow us to make inferences on advertising-induced changes in the dispersion of consumers' valuations in the market by observing the revealed preferences of producers participating in the programs. Although this approach is clearly limited in scope to examining collectively-funded advertising programs, it has the advantage of being based on the preferences of actual market participants.

There are well-known empirical challenges to measuring the degree of complementarity between goods in individual utility functions containing an arbitrary collection of goods. Take for example Samuelson's (1974) discussion of coffee, tea, and cream. Coffee and tea are substitutes, and both coffee and tea are complementary to cream. If cream is "more complementary" to tea than to coffee –in the sense that consumers use more cream in a cup of tea than they use in a cup of coffee– then a rise in the price of coffee that causes consumers to drink less coffee and more tea can lead to a rise in cream sales. In the case of complementarity between advertising and advertised goods, moreover, the link between advertising and market performance is further complicated by the need to address the higher-order effect of advertising on the dispersion of consumers' valuations.

Our approach overcomes some of the objections to earlier studies of the impact of advertising on the market performance of advertised goods. Following Bain (1956) and Comanor and Wilson (1967, 1974), a large literature has developed that seeks

to empirically identify the linkage between advertising and market performance in market data; however, measurement and endogeneity issues confound the interpretation of these results. Changes in demand over time can be driven by a number of factors unrelated to the advertising expenditure of a given firm or industry. Current advertising and sales levels can also affect future demand, as would be the case when "social status" is durable or when temporal consumption levels lead to habit formation, and this requires specifying a distributed lag structure (Clarke 1976; Erdem and Keane 1996; Ackerberg 2001). Moreover, advertising firms may be attracted to industries with inelastic demand conditions, and multi-product retailers may use advertised brands as loss-leaders to facilitate the sales of related retail goods. Such empirical complications may explain the conflicting findings of studies that estimate the effect of advertising on the price elasticity of demand.[3]

Experimental evidence on the effect of advertising on market performance is also mixed. Natural experiments, for instance Benham's (1972) well-known study on advertising bans in the eyeglass market and the related studies by Cady (1976) and Kwoka (1984), generally find prices to be lower in regions allowing advertising relative to regions that impose advertising bans.[4] In contrast, the general outcome of laboratory and field experiments, for instance the interesting "split cable" TV field experiment by Krishnamurthi and Raj (1985), is that adverting decreases the elasticity of demand (Kaul and Wittink 1995).[5]

Our observations are closely related to those of Johnson and Myatt (2006), who show that informative advertising results in a clockwise rotation of demand when information increases the dispersion of consumer valuations. Consumer valuations can become more disperse when advertisements provide information on attributes

[3]For a recent review see Erdem, Keane and Sun (2008).

[4]An objection to these studies is that they do not achieve randomization when advertising bans in political jurisdictions are not exogenous to prices. A recent study by Milyo and Waldfogel (1999) remedies this problem by using longitudinal data on liquor products in Rhode Island and Massachusetts that extends over the period in which the Supreme Court overturned Rhode Island's ban on liquor price advertising; however, they find the lifting of the advertising ban to have no significant effect on prices.

[5]For the case of laboratory experiments, recent evidence suggests that lab respondents may express systematically higher willingness to pay values than actual market participants (List 2006).

for which consumers have subjective tastes.[6] Johnson and Myatt (2006) classify advertising that leads to outward shifts in market demand as "hype" and refer to advertising that leads to clockwise rotations of market demand as providing "real information". Although we believe the rigid classification of advertising as "hype" and "real information" to be overly restrictive, it is clear that the decomposition between level effects and rotation effects provides a reasonable taxonomy for examining advertising-induced changes in market demand.

We see no reason why persuasive advertising ("hype") cannot also influence the dispersion of consumers' valuations.[7] Mullainathan, Schwartzstein, and Shleifer (2008) have recently formalized a psychological role for persuasive advertising to influence the behavior of "coarse thinkers" through product associations, for instance the association made between hair and silk in Shampoo advertisements. Such advertising would increase the dispersion of consumers' valuations if coarse thinkers tend to populate the extremes of the value distribution. But it is also conceptually possible for advertising to decrease the dispersion of consumers' valuations. Indeed, as Becker and Murphy (1993, p. 955) observe, firms may "try to tailor their advertising to bring up the demands of marginal consumers since these drag down the equilibrium price paid by inframarginal consumers."

We organize the remainder of the paper as follows. In the following section, we briefly describe the generic advertising program that frames our study: the "Beef. It's what's for dinner!" campaign. This is an ideal market to study for three reasons: (i) participation in the generic advertising program is mandatory for all beef sold in the U.S., (ii) there is considerable variation in the operating scale of individual beef producers, and (iii) the U.S. Department of Agriculture recently completed a comprehensive survey of producer preferences for the generic advertising program that categorizes respondents based on producer size. In Section III, we formulate a

[6] Schmalensee (1978) and Ackerberg (2001) also point out that informative advertising may make some consumers less inclined to buy the product.

[7] It is worthwhile to note that a change in the dispersion of consumers' valuations has consequences only at the upper tail of the value distribution since consumers at the lower tail do not purchase the product.

model that links changes in the dispersion of consumers' valuations to changes in the distribution of rents among individual producers in a generic advertising program. In Section IV, we derive implications of the model for producer preferences towards expanding generic advertising in the Beef Chaeckoff program. Section V describes our empirical approach and presents our estimation results.

2 Generic Advertising for U.S. Beef

We examine the preferences of members of the Beef Checkoff Program who fund the "Beef. It's what's for dinner!" advertising campaign. This section briefly describes the institutional details and history of this generic advertising program.

Virtually every agricultural commodity sold in the U.S. relies on mandatory fees among members for generic promotion. The earliest forms of generic advertising programs were funded through voluntary contributions among members and suffered from common property problems. To resolve these problems, pressure among industry groups led to the passage of the Agricultural Marketing Agreement Act of 1937 and the subsequent formation of State and Federally-mandated checkoff programs.

The Beef Checkoff Program was formalized by the Beef Promotion and Research Act of 1985. Under the Beef Promotion and Research Act, a $1 per head checkoff fee is levied on all sales or importation of cattle in the U.S. This assessment is used to fund promotional activities for beef by a Federally-appointed Cattleman's Beef Research and Promotion Board.[8]

Since the 1985 decision, various beef producers have constitutionally challenged the Beef Checkoff Program on the basis that generic advertising violates an individual's right to free speech. For instance, a mandatory assessment might force beef producers to pay for an advertising message they do not support. In 2001, the U.S. trial court ruled the Beef Checkoff Program to be unconstitutional. This decision was appealed and subsequently overturned by the Supreme Court in 2005, where it was

[8]See, the Agricultural Marketing Agreement Act of 1937 (7 U.S.C. § 601 et seq.) and the Beef Promotion and Research Act of 1985 (7 U.S.C. § 2901 et seq.).

decided that advertising by the Beef Checkoff Program did not violate the constitutional rights of members on the ground that generic advertising serves as a form of government speech.[9]

It is often argued that generic advertising programs harm producers who seek to develop niche market positions. For example, generic advertising by the National Pork Board, which promotes pork as "the other white meat," was recently contested by niche market producers who were seeking to emphasize quality attributes such as tenderness, pH, and water-holding capacity that are more prevalent in darker meats with higher intramuscular fat (Honeyman et al., 2006). We believe the implication goes the other way. In principle, there is no reason why advertising messages cannot increase the dispersion of consumers' valuations, for instance generic beef advertising might raise the valuations of consumers of Kobe-style beef on the high willingness-to-pay segment of the market to a greater extent than advertising raises the valuations of consumers on the low willingness-to-pay segment of the market. Such advertising would lead to relatively favorable outcomes for producers who adopt niche market positions at the expense of producers adopting mass market positions. Our view is that the observation of systematic characteristics among producers who oppose generic advertising programs reveals the role of advertising in changing the dispersion of consumers' valuations.

3 The Model

Our model is framed around generic advertising in a homogeneous product oligopoly market. The advertising level is administered by a marketing board that levies a per-unit checkoff fee on the output of members in the program. Membership in the program is mandatory and the marketing board uses all checkoff fee revenues to acquire generic advertising messages through forward contracts with a competitive advertising industry. For analytic convenience, we consider advertising contracts that

[9]See Livestock Marketing Assoc. (LMA) v. USDA (132 F. Supp. 2d 817 (D. S.D. 2001), and Johanns, et al. v. LMA (544 U.S. 550 2005).

fully dissipate checkoff fee revenues in the market under complete information.[10]

Advertising expenditure is given by $A = \tau Q$, where τ is the checkoff fee and Q is the market output level. Inverse demand in the market is $P(Q, \tau)$, which is downward-sloping in industry output, $P_Q(Q, \tau) < 0$ and concave in the checkoff rate; $P_\tau(Q, \tau) > 0$, $P_{\tau\tau}(Q, \tau) < 0$. We classify the rotation effect of advertising on demand as follows: (i) $P_{Q\tau}(Q, \tau) = 0$ for a parallel shift; (ii) $P_{Q\tau}(Q, \tau) < 0$ for a clockwise rotation; and (iii) $P_{Q\tau}(Q, \tau) > 0$ for a counterclockwise rotation. The effect of advertising on market demand can then be decomposed into an outward shift and rotatation component, where advertising can increase the dispersion of consumers' valuations (leading to a counterclockwise rotation at the equilibrium output level) or decrease the dispersion of consumers' valuations (leading to a clockwise rotation).

The demand rotation effects in our model correspond to changes in the advertising-output ratio, $\tau = A/Q$. This differs from the approach of Telser (1964) and the literature that follows that examines how changes in the advertising-sales ratio affect market performance. Under circumstances in which a generic advertising program collects fees on an ad valorem basis at rate α on sales, $A = \alpha p Q$, rotation effects on demand that arise from changes in α correspond to examining the effect of changes in the advertising-sales ratio on market performance.

The solution concept for the market equilibrium is Nash in quantities. We take the number of firms (n) to be exogenous, which reflects the presence of a fixed factor of production, for instance ownership of scarce land assets, of which the firms have asymmetric endowments. Profits persist in the form of rents returned to the fixed factor, and the outcome can approximate competitive market conditions in the usuual case where the number of operating firms is large. We refer to the fixed factor as "capital" and denote the capital endowment of firm i.by k_i,$i = 1, \ldots, n$.

[10]Some marketing boards allocate a share of revenues from checkoff fees to research and development activities; however, the vast majority of checkoff revenues in agricultural markets is spent on generic advertising and promotion activities (Williams and Capps, 2006).

3.1 Market Outcome

The total cost to firm i of producing the output level q_i is given by $c^i(q_i, k_i)$. We follow Perry and Porter (1985) and Farrell and Shapiro (1990) in assuming the production cost of firm i to be increasing in output, $c_q^i \equiv \partial c^i(q_i, k_i)/\partial q_i > 0$, and marginal production cost to be decreasing in the firm's endowment, $c_{qk}^i \equiv \partial^2 c^i(q_i, k_i)/\partial q_i \partial k_i < 0$.

Firm i takes the checkoff rate τ as parametric and selects the output level, q_i, to maximize profits, $\pi^i(q_i, k_i, Q, \tau) \equiv p(Q, \tau)q_i - c^i(q_i, k_i) - \tau q_i$, given the output levels selected by his rivals. The first-order condition for firm i is

$$\pi_i^i \equiv p(Q, \tau) + q_i p_Q(Q, \tau) - c_q^i(q_i, k_i) - \tau = 0, \ i = 1, \ldots, n. \tag{1}$$

Letting $\tilde{k} \equiv (k_1, ..., k_n)$ denote the industry-wide vector of capital stocks, the Nash equilibrium is a vector of quantities, $\tilde{q}^*(\tau, \tilde{k}) = (q_1^*(\tau, \tilde{k}), ..., q_n^*(\tau, \tilde{k}))$ that satisfies equation (1) for each of the n firms.[11]

We employ the standard existence and stability conditions (see Vives 1999, pp 96-97),

$$\theta_i \equiv p_Q(Q, \tau) + q_i p_{QQ}(Q, \tau) < 0, \ i = 1, \ldots, n, \tag{2}$$

$$\bar{\omega}_i \equiv c_{qq}^i(q_i, k_i) + p_Q(Q, \tau) > 0, \ i = 1, \ldots, n. \tag{3}$$

In addition, we denote (without restriction) the effect of a change in the checkoff fee on the marginal revenue of firm i by

$$\gamma_i \equiv p_\tau(Q, \tau) + q_i P_{Q\tau}(Q, \tau) - 1, \ i = 1, \ldots, n. \tag{4}$$

Notice that advertising messages that involve only level effects on market demand, $p_{Q\tau}(Q, \tau) = 0$, do not lead to firm-specific changes in marginal revenue. Level effects on market demand uniformly raise marginal revenue for all firms. In contrast, advertising messages that create both level effects and rotation effects on market

[11] Notice that it follows from this condition that the equilibrium level of output is larger for firms with relatively highly levels of capitalization; that is, $q_i^* > q_j^*$ if and only if $k_i > k_j$.

demand raise marginal revenue by more for firms with large output levels than for those with smaller output levels when $p_{Q\tau}(Q,\tau) > 0$, and lower marginal revenue disproportionately for firms with large output level when $p_{Q\tau}(Q,\tau) < 0$.

Making use of conditions (1)-(4), the effect of an increase in the checkoff rate on individual and aggregate output levels can be examined by totally differentiating equation (1). Doing so yields

$$\theta_i dQ - \bar{\omega}_i dq_i + \gamma_i d\tau = 0.$$

Rearranging this equation, the change in output for firm i is given by

$$dq_i = -\lambda_i dQ + \delta_i d\tau. \tag{5}$$

where $\lambda_i = -(\theta_i/\bar{\omega}_i)$ and $\delta_i = \gamma_i/\bar{\omega}_i$.

The distribution of λ_i's and δ_i's in the industry are critical. λ_i measures firm i's equilibrium output responsiveness to changes in the market price that occur through movements along the demand curve and is related to the slope of firm i's reaction function. Namely, $\lambda_i \equiv R_i/(1-R_i)$, where $R_i \in (0,1)$ denotes the slope of firm i's reaction function (in absolute terms). Similarly, δ_i measures the sensitivity of firm i's equilibrium output response to changes in the checkoff rate.

The change in total output following an arbitrarily small change in the level of advertising sums equation (5) across firms, which gives

$$dQ = \left(\frac{\delta}{(1+\lambda)}\right) d\tau \tag{6}$$

where $\lambda = \sum_i \lambda_i$ and $\delta = \sum_i \delta_i$. Noting that $\lambda_i > 0$ for all i under our assumptions, $\lambda > 0$, and it follows that a marginal increase in the checkoff rate increases the market output level only if $\delta > 0$, where the sign of δ_i is given by equation (4). The intuition is that the demand facing producers net of the checkoff fee is unaltered by the program when a marginal increase in the checkoff rate of $d\tau$ units leads to a parallel shift in market demand of $p_\tau(Q,\tau)d\tau = d\tau$ units since the unit checkoff fee is entirely passed through to consumers. For a change in the checkoff rate that satisfies $d\tau =$

$p_\tau(Q,\tau)d\tau$, generic advertising that increases the dispersion of consumers' valuations, $p_{Q\tau}(Q,\tau)d\tau < 0$, results in a decrease in the equilibrium output level, whereas generic advertising that decreases the dispersion of consumers' valuations, $p_{Q\tau}(Q,\tau)d\tau > 0$, results in an increase in the equilibrium output level in the industry.

3.2 Industry Optimal Advertising

The objective of the marketing board is to maximize industry profits through the selection of a unit checkoff fee. Given the equilibrium output level in equation (1), the optimal checkoff rate solves

$$Max_\tau \Pi(\tau,\tilde{k}) \equiv \sum_i \pi^i(\tau,\tilde{k}) = p(Q(\tau,\tilde{k}),\tau)Q(\tau,\tilde{k}) - \sum_i c^i(q_i(\tau,\tilde{k}),k_i) - \tau Q(\tau,\tilde{k}).$$

The first-order necessary condition is

$$(p + p_Q Q - \tau)(dQ/d\tau) - \sum_i c^i(dq_i/d\tau) + p_\tau Q - Q = 0, \tag{7}$$

where arguments are suppressed for notational convenience. Substituting $dQ/d\tau = \sum_i dq_i/d\tau$ into equation (7), making use of equation (1), and converting the resulting expression into market shares gives

$$p_\tau - 1 + p_Q\left(\frac{dQ}{d\tau} - \sum_i s_i \frac{dq_i}{d\tau}\right) = 0, \tag{8}$$

where $s_i = q_i/Q$ is the market share of firm i. Let τ^* denote the industry optimal advertising level that solves equation (8).

The intuition for equation (8) is straightforward. The first two terms on the left-hand side are the direct effects of a marginal advertising unit on industry profit. A marginal increase in generic advertising of $d\tau$ units has a direct effect on the net price received by producers of $(p_\tau - 1)d\tau$ units. The remaining term in (8), which can be written $p_Q(\sum_i(1-s_i)\partial q_i/\partial\tau)$, adjusts the advertising level to account for the oligopoly externality in the market, as externalities between members is something the marketing board can resolve.

It is generally the case that industry output decreases on the margin in response to an increase in the dispersion of consumers' valuations, $p_{Q\tau} < 0$, and increases following a decrease in the dispersion of consumers' valuations, $p_{Q\tau} > 0$. For instance, consider the symmetric outcome under a standard regularity condition on the elasticity of the slope of inverse demand:

$$E = \frac{-Qp_{QQ}(Q,\tau)}{p_Q(Q,\tau)} \leq 1. \tag{9}$$

Condition (9) rules out cases in which an increase in marginal cost raises industry profits and implies that $\psi \equiv c_{qq} - 2p_Q - Qp_{QQ} > 0$ for the representative firm. Making use of this in equation (6) and imposing symmetry, the change in industry output from a change in the checkoff rate is

$$\frac{\partial Q}{\partial \tau} = \frac{n(p_\tau - 1) + Qp_{Q\tau}}{\psi}. \tag{10}$$

Substituting this term into equation (8) and rearranging gives

$$\left(\frac{p_\tau - 1}{p_{Q\tau}}\right)\psi = -\left(\frac{n-1}{n}\right)Qp_Q. \tag{11}$$

Noting that the right-hand side of equation (11) is positive, it follows that $p_\tau - 1 \overset{s}{=} p_{Q\tau}$, where "$\overset{s}{=}$" denotes "equals in sign". By inspection of equation (10), industry output decreases on the margin in response to $d\tau > 0$ when advertising increases the dispersion of consumers' valuations, $p_{Q\tau} < 0$, and increases when advertising reduces the dispersion of consumers' valuations, $p_{Q\tau} > 0$.

When a marginal unit of generic advertising involves only a level effect on demand, $p_{Q\tau} = 0$, and satisfies $p_\tau d\tau = d\tau$, the increase in advertising leads to no change in the demand conditions facing producers, and hence has no effect on firm or industry profitability on the margin. A symmetric industry would cease advertising at this point (since $p_{\tau\tau} < 0$). If advertising combines a level effect on market demand with an increase in the dispersion of consumers' valuations, $p_{Q\tau} < 0$, then industry output decreases in equilibrium, widening price-cost margins for firms selling the advertised good and commensurately raising the return to advertising on the margin. Further advertising is optimal, so that $p_\tau - 1 < 0$ at the industry optimum. Conversely,

$p_\tau - 1 > 0$ at the industry optimum when generic advertising decreases the dispersion of consumers' valuations in the market, $p_{Q\tau} > 0$.

When firms in an industry have different factor endowments, the advertising level that maximizes industry rents also accounts for changes in allocative efficiency. If advertising redistributes industry output towards firms with "small" capital endowments and away from highly-capitalized firms, this raises industry costs by increasing the market shares of less-efficient firms.[12]

3.3 Individually Optimal Advertising

The optimal adverting level for firm i solves

$$Max_\tau \pi^i(\tau, \tilde{k}) \equiv p(Q(\tau, \tilde{k}), \tau) q_i(\tau, \tilde{k}) - c^i(q_i(\tau, \tilde{k}), k_i) - \tau q_i(\tau, \tilde{k}),$$

which is characterized by the rate of change:

$$\frac{d\pi_i}{d\tau} = (p - c_q^i - \tau)\frac{dq_i}{d\tau} + q_i P_Q \frac{dQ}{d\tau} + p_\tau q_i - q_i.$$

Substituting terms from equation (1) gives

$$\frac{d\pi_i}{d\tau} = (p_\tau - 1)q_i + q_i P_Q \frac{d(Q - q_i)}{d\tau}. \tag{12}$$

Each term on the right-hand side of equation (12) has a straightforward interpretation. The first term is the direct effect of advertising on the marginal profit of firm i. A change in the check-off rate of $d\tau$ units raises revenue by $p_\tau q_i d\tau$ units and cost by $q_i d\tau$ units. The second term is the indirect effect of advertising on the profit of firm i. Holding firm i's output constant, the profit of firm i is influenced indirectly by the change in the market price resulting from the change in output of its rivals, $Q - q_i$, in response to an increase in generic advertising.

Inspection of equations (8) and (12) reveals the difference in industry-optimal and privately-optimal advertising levels. The industry-optimal level of advertising rises in

[12] Such would be the case if advertising decreases the dispersion of consumers' valuations and firms with greater levels of capitalization have steeper marginal cost functions (i.e., $c_{qq}^i(., k_i) > c_{qq}^j(., k_j)$ for $k_i > k_j$).

the share-weighted sum of individual output changes, whereas the privately-optimal advertising level rises in the firm's own output change. Formally, evaluating terms in equation (12) at τ^* gives

$$\left.\frac{d\pi_i}{d\tau}\right|_{\tau=\tau^*} = -q_i p_Q \left[\left.\frac{dq_i}{d\tau}\right|_{\tau=\tau^*} - \sum_i s_i \left(\left.\frac{dq_i}{d\tau}\right|_{\tau=\tau^*} \right) \right]. \tag{13}$$

Notice that the term in the square brackets goes to zero in the symmetric case, $s_i = 1/n$. That is, all firms desire the industry optimal advertising level in the symmetric case. When the factor endowments of firms differ, rents are redistributed in the industry between firms according to the difference between the change in "own output" and the share-weighted change in industry output.

By inspection of (13), firm i desires a higher level of advertising than τ^* only if generic advertising expenditures raise the output level of firm i on the margin by more than the increase in the share-weighted output of his rivals. Highly capitalized firms desire more (less) advertising relative to firms with smaller capital endowments when generic advertising raises the output level of each firm, which occurs following a decrease (increase) in the dispersion of consumers' valuations.

4 Advertising Outcomes and Firm Scale

In this section we follow Perry and Porter (1985) and Farrell and Shapiro (1990) and consider a specialization of the model with linear demand ($p_{QQ} = 0$) and quadratic costs.[13] Specifically, suppose inverse demand is $p(Q, \tau) = \alpha(\tau) - \beta(\tau)Q$ and variable cost for firm i is given by $c(q_i, k_i) = 0.5q_i^2/k_i$.[14] In this case, $c_q^i = q_i/k_i$ and $c_{qq}^i = k_i^{-1}$, so that highly capitalized firms have flatter marginal cost functions (and hence flatter reaction functions) than firms with smaller capital endowments. Advertising messages that produce level effects on market demand affect $\alpha(\tau)$, whereas changes in the dispersion of consumers' valuations are captured by rotation effects in $\beta(\tau)$.

[13] Qualitatively similar conclusions emerge in a model with general demand conditions and linear costs.

[14] This cost function, which is homogeneous of degree one, is the dual to a Cobb-Douglas production function with $q = \sqrt{LK}$

First-order condition (1) satisfies $\alpha(\tau)-\beta(\tau)Q-\beta(\tau)q_i-(q_i/k_i)=\tau$. This condition can be written as $q_i(\tau)=\kappa_i(\tau)(p(\tau)-\tau)$, where $\kappa_i(\tau)\equiv k_i(1+\beta(\tau)k_i)^{-1}$ denotes firm i's "adjusted" capital stock. Notice that each firm's output level is proportional to its adjusted capital stock and that changes in the slope of inverse demand alter the adjusted capital stock of each firm. Letting $\kappa(\tau)=\sum_i \kappa_i(\tau)$ denote the aggregate adjusted capital stock, the equilibrium output levels are given by $q_i^*(\tau)=\frac{(\alpha(\tau)-\tau)\kappa_i(\tau)}{1+\beta(\tau)\kappa(\tau)}$, for $i=1,\ldots n$, and $Q^*(\tau)=\frac{(\alpha(\tau)-\tau)\kappa(\tau)}{1+\beta(\tau)\kappa(\tau)}$.

Notice that the market share of each firm is given by its share of the industry adjusted capital stock, $s_i^*\equiv q_i^*/Q^*=\kappa_i(\tau)/\kappa(\tau)$; hence, advertising influences market share only through changes in the slope of market demand since such changes alter the adjusted capital stocks of individual firms. Differentiating these expressions, individual and aggregate outputs adjust in response to a change in the checkoff fee according to

$$\frac{dq_i^*(\tau)}{d\tau} = \left(\frac{\kappa_i(\tau)}{1+\beta(\tau)\kappa(\tau)}\right)\left[\alpha'(\tau)-\beta'(\tau)Q^*(\tau)-1\right], \tag{14}$$

$$\frac{dQ^*(\tau)}{d\tau} = \left(\frac{\kappa(\tau)}{1+\beta(\tau)\kappa(\tau)}\right)\left[\alpha'(\tau)-\beta'(\tau)Q^*(\tau)-1\right]. \tag{15}$$

Because the market share of each firm is determined by its share of the industry adjusted capital stock, a change in the level of advertising induces a proportional output adjustment for each firm. Individual output levels rise for all firms in response to a marginal increase in the checkoff rate if $\beta'(\tau)Q^*<\alpha'(\tau)-1$, and otherwise fall.

The industry optimal solution is characterized by substituting (14) and (15) into (7) and making the substitution $\kappa_i=s_i\kappa$, which yields

$$\frac{(\alpha'(\tau)-\beta'(\tau)Q(\tau)-1)\kappa(\tau)(1-H(\tau))}{1+\beta(\tau)\kappa(\tau)}=\alpha'(\tau)-1,$$

where $H(\tau)=\sum_i (s_i(\tau))^2$ is the Herfindahl index of industry concentration. Rearranging this equation, the industry optimal level of advertising solves

$$\beta(\tau)\kappa(\tau)Q(\tau)\beta'(\tau)(1-H(\tau))=(1-\alpha'(\tau))(1+\beta(\tau)\kappa(\tau)H(\tau)).$$

This equation implicitly defines τ^*. Notice in the case where generic advertising results in a parallel shift in demand ($\beta'(\tau) = 0$) that the industry optimum involves purchasing advertising messages until the outward shift in demand from the last unit of advertising equates with the level of the per unit check-off fee ($\alpha'(\tau) = 1$).

Under circumstances in which generic advertising increases the dispersion of consumers' valuations, $\beta'(\tau) > 0$, the market power of firms in the industry rises, increasing the rents to advertising. Accordingly, advertising shifts market demand on the margin by less than the unit check off rate, $\alpha'(\tau) < 1$. Advertising reduces aggregate output in this case and serves to increase the price cost margins of firms. Conversely, when advertising decreases the dispersion of consumers' valuations, $\beta'(\tau) < 0$, price-cost margins fall on the margin in response to advertising, reducing advertising rents. In this case, advertising shifts market demand on the margin by more than the unit check off rate, $\alpha'(\tau) > 1$.

To assess the advertising preferences of individual firms, substitute (14) and (15) into equation (13) and make the substitution $\kappa_i = s_i\kappa$ to get

$$\left.\frac{d\pi_i}{d\tau}\right|_{\tau=\tau^*} = q_i\beta(\tau)(s_i - H)\frac{dQ^*}{d\tau}.$$

Firm i desires the socially optimal advertising level only when one of two conditions is met: (i) firm i has market share given by $s_i = H$, or (ii) advertising produces a parallel shift in demand on the margin (recall that $dQ/d\tau = 0$ at τ^* only in the case of a parallel shift). If advertising increases the dispersion of consumers' valuations, $\beta'(\tau) > 0$, then $dQ/d\tau < 0$ at τ^*, and "small" firms with market shares that satisfy $s_i < H$ prefer a greater level of advertising than the industry optimal level, whereas, if advertising decreases the dispersion of consumers' valuations, $\beta'(\tau) < 0$, then $dQ/d\tau > 0$ at τ^*, and "slarge" firms with market shares that satisfy $s_i > H$ prefer a greater level of advertising than the industry optimal level.

When firms differ in capital endowments, increases in market output are generally distributed according to market share. Highly capitalized firms, which have higher price-cost margins in equilibrium than less capitalized firms, consequently earn a disproportionate share of industry rents from policies that lead to an expansion of

industry output. For this reason, advertising messages that decrease the dispersion of consumers' valuations favor low-cost firms since this increases the price elasticity of demand at the equilibrium point.

5 Empirical model and discussion

We draw on data from a survey conducted for the U.S. Department of Agriculture by the Gallop Organization on the attitudes of beef producers towards the Beef Checkoff Program (USDA 2006). These data represent the most comprehensive information available on producer attitudes towards generic advertising and include categorical variables on the size of producers.[15]

Our model predicts that small (large) producers receive a disproportionately large share of advertising rents when advertising increases (decreases) the dispersion of consumers' valuations in the beef market. This observation allows us to make inferences on the effect of advertising on market performance by examining the revealed preferences of producers of different sizes for a policy that seeks to expand the checkoff-funded generic advertising program.

The USDA-Gallop survey elicits responses for three questions on producer preferences for the generic advertising. Two questions ask producers to reveal their "blanket-level" support for the Beef Checkoff Program. These questions categorize responses regarding producers' overall level of approval for the program (on a range between "strongly disapprove" to "strongly approve"), and record whether producers would vote to continue the program in a referendum. The response pattern to these questions appeared similar. For example, 77 percent of the sample either "strongly approved" or "approved" the actions of the Checkoff Board, and 79 percent stated that they would be either very likely or somewhat likely to vote to continue the existing Beef Checkoff Program.

The third question is central to our study and asks respondents whether they

[15]The sample was stratified by state and firm size and produced 8004 collected surveys. This sample is representative of a population believed to be around 1 million producers (USDA, 2006).

would prefer to decrease (=1), maintain (=2) or increase (=3) the existing $1 per head checkoff fee. This question is central to our study since the responses reveal individual preferences for changes in advertising levels on the margin. Only 6.3 percent of respondents preferred a larger checkoff fee to support greater levels of generic advertising.

Table 1 describes the demographic variables in the data. The calculated means are from the 5077 surveys in which definitive responses were provided to all relevant questions.[16] Categorical variables are recorded for age, gender, primary operation type, and secondary operation activities. Additionally, seven size categories are provided, ranging from 1-19 head of cattle in the smallest size category to over 1,000 head in the largest size category. The USDA (2006) provides a thorough descriptive assessment of the survey.

We derive preliminary results from a probit model using size categories to predict preferences for expanding generic advertising levels in the Beef Checkoff Program. We drop the largest size category (SZ7) from the regression and estimate the probability of favoring program expansion for each of the remaining size categories.

Table 2 presents the results of the probit model. Notice that producers in the four smallest categories (SZ1-SZ4) are each statistically less likely to support an increase in checkoff-funded advertising relative to the largest producers, while producers in the three largest categories (SZ5 SZ6 and SZ7) are not statistically different. These preliminary results suggest a positive correlation exists between firm size and the propensity to favor larger levels of generic advertising.

Given the considerable heterogeneity among survey respondents (both observed and unobserved), the relationship between firm size and the propensity to favor greater advertising levels is confounded by a number of econometric issues. To account for heterogeneous factors among producers and the potential correlation between unobserved factors that jointly explain program support and preferences for expanded advertising levels, we estimate a bivariate ordered probit model with the full set of

[16] Surveys with responses of "don't know" or "refused to answer" were dropped from the analysis.

explanatory variables listed in Table 1.

The unobserved propensities of respondents to approve the generic advertising program and favor program expansion are represented by latent constructs y^*_{j1} and y^*_{j2}, respectively, which take the form:

$$y^*_{i,1} = \beta'_1 \mathbf{x}_{i,1} + \varepsilon_{i,1}, \quad y_{i,1} = j \quad \text{if } \mu_{j-1,1} < y^*_{i,1} < \mu_{j,1}, \tag{16}$$

$$y^*_{i,2} = \beta'_2 \mathbf{x}_{i,2} + \varepsilon_{i,2}, \quad y_{i,2} = k \quad \text{if } \mu_{k-1,2} < y^*_{i,2} < \mu_{k,2}, \tag{17}$$

where β_1 and β_2 are the coefficient vectors, $\mathbf{x}_{i,1}$ and $\mathbf{x}_{i,2}$ are the exogenous regressors, $\varepsilon_{i,1} \sim N[0,1]$ and $\varepsilon_{i,2} \sim N[0,1]$ are the errors terms, which are assumed to be distributed bivariate standard normal with correlation parameter ρ. The μ's are cutoff values that frame the observed ordered responses. The explanatory variable of interest is the size of grower i's operation, which we measure as the median number of cattle sold in each size category. The remaining variables in $\mathbf{x}_{i,1}$ and $\mathbf{x}_{i,2}$ are producer-specific attributes that may influence preferences for the generic advertising program.

We refer to equation (16) as the "approval" model and to equation (17) as the "WTP" model. Our primary interest is whether producer size explains the probability that a producer is willing to pay a higher checkoff fee to finance greater advertising levels, after controlling for observed and unobserved factors that explain individual preferences for the program.

We estimate the model using full-information maximum likelihood, which results in consistent estimates for all parameters. We conduct three pretests to evaluate potential parameter fragility and model misspecification. First, we replace the "approval" model with a model that uses voting preferences as the dependent variables in equation (16). Second, we estimate a model that replaces the categorical variable on firm size with the SZ1-SZ6 dummy variables used in our preliminary analysis. Third, we censor the sample to remove 545 out of 5077 respondents who admitted to not being informed on the activities of the Beef Checkoff Program. Our results in each case are robust.

Table 3 presents our estimates of model coefficients with robust standard errors. A chi-square test of the model relative to a null model with all parameters restricted to zero rejects the null ($\chi^2 = 94.58$). A chi-squared test of the correlation coefficient ρ, which represents a specification test of the bivariate ordered probit structure, rejects the hypothesis of no cross equation correlation of the errors.

With the exception of the binary variable for dairy operations in the approval model, operation type is not a significant predictor of approval or WTP for the program. However, individual F-tests of the hypotheses that the operation type binary variables are jointly equal to zero are statistically significant in both equations (approval: $\chi^2 = 68.56$; WTP: $\chi^2 = 12.25$).

Relative to the oldest producers (65+), the youngest producers in the sample are more supportive of the checkoff program and are also significantly more likely to support an increase in checkoff-funded advertising levels. This finding suggests a potential investment component for generic advertising in raising consumer demand for beef in the long run.

The binary terms reflecting secondary operations are insignificant in the approval model, as is the F-test of their joint significance (approval: $\chi^2 = 1.56$). In the WTP model, growers without a secondary operation are less likely to support expansion of the checkoff program and the joint F-test for both binary terms is marginally significant (approval: $\chi^2 = 5.36$)

Notably, after controlling for age, gender, and operational differences among producers, we find that larger operators are significantly more likely to support greater levels of generic advertising. In the WTP model, producers stated their preference for one of three categorical choices over the extent of the generic advertising program: to reduce the $1 per head checkoff fee, to maintain the fee at the existing level, or to increase the checkoff fee. Our results indicate that an increase in operation size results in a rightward shift in the probability density over the choice regions. The bottom rows of Table 3 present the results of a 10% increase in firm size are on the probability distribution. The location of the cut points (cut21=-1.041 and cut22=1.633) in

the error structure of the WTP equation define the boundaries from which we measure changes in probabilities in response to the adjustment in firm size (see Greene and Hensher, 2008; Sajaia, 2008). The large cut22 value is representative of the low probability density associated with a preference for program expansion, as only 6.3 percent of respondents supported an increase in checkoff fees above the current level. Overall, a 10 percent increase in firm size of a typical producer results in a 0.58 percent increase in the probability of supporting an expansion of the Beef Checkoff Program and a 0.41 percent decrease in the probability of supporting a contraction. The positive relationship between producer size and the preference for expanding the generic advertising program suggests that advertising has reduced the dispersion of consumers' valuations in the beef market.

Generic beef advertising appears to have reduced the dispersion of consumers' valuations for beef. This finding is consistent with the notion advocated by Becker and Murphy (1993) that the primary role of advertising is to increase the valuation of marginal consumers. In the case of generic beef advertising, our results are in accord with the views of Ozga (1960), Stigler (1961), Telser (1964) and Nelson (1970, 1974) that advertising enhances performance in markets for advertised goods.

6 Conclusions

In this paper we have examined the actions of individual market participants in response to generic advertising programs in the Beef Checkoff Program. We show that large firms benefit disproportionately from generic advertising programs when advertising decreases the dispersion of consumers' valuations, whereas small firms benefit disproportionately from generic advertising programs when advertising increases the dispersion of consumers' valuations. This observation provides a simple identification strategy for measuring advertising-induced changes in the market power of advertising firms by examining differences in the preferences of large and small operators in generic advertising programs.

Our empirical goal is fundamentally descriptive in the sense that we do not pro-

pose a "test" for a particular theory of the mechanism through which advertising alters consumers' valuations for advertised goods. Instead, our approach relies on the revealed preferences of individual producers in a collective advertising program to inform on changes in the dispersion of consumers' valuations in the market.

We considered the preferences of beef producers towards expanding the generic advertising program as revealed in recent USDA-Gallop data from the U.S. Beef Checkoff Program. We find that the probability that a producer favors expanding the generic advertising program is higher for large producers than for smaller producers, an outcome consistent with an advertising-induced decrease in the dispersion of consumers' valuations and a commensurate increase in market performance. This finding is echoed in the recent actions by producers in a number of commodity marketing orders who have legally challenged mandatory participation in generic advertising programs on the grounds that generic messages are inconsistent with adopting niche market positions. Niche market producers rely on advertising messages to raise the valuations of consumers on the "high WTP" segment of market demand and would benefit accordingly from advertising messages that increase the dispersion of consumers' valuations. Our findings are consistent with this anecdotal evidence and in accord with the views of Becker and Murphy (1993) that the primary role of advertising is to raise the valuation of marginal consumers.

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Table 1. Description of the data

	Mean	St. Dev.	Min	Max
Expand[a]	1.9391	0.4276	1	3
Approve[b]	3.8410	1.2360	1	5
Gen1(Male = 1)	0.9293	0.2563	0	1
Age1(< 40 yrs.)	0.0473	0.2123	0	1
Age2(40- 55 yrs.)	0.2919	0.4547	0	1
Age3 (55-65 yrs.)	0.2824	0.4501	0	1
Age4 (> 65 yrs.)	0.3785	0.4851	0	1
Op1 (cow/calf)	0.7094	0.4540	0	1
Op2 (dairy)	0.0912	0.2879	0	1
Op3 (farmer/feedlot)	0.0734	0.2611	0	1
Op4 (feedlot)	0.0234	0.1513	0	1
Op5 (livestock marketing)	0.0083	0.0905	0	1
Op6 (seedstock/purebread)	0.0399	0.1959	0	1
Op7 (stocker)	0.0433	0.2036	0	1
Op8 (all other)	0.0108	0.1035	0	1
Nso (no secondary op.=1)	0.6183	0.4859	0	1
Noco (secondary op. not cattle=1)	0.1564	0.3633	0	1
Size (category means)[c]	0.1511	0.2377	0.01	1.5

.65in.5in

Notes:
[a]Expand: "In your opinion, should the $1-per-head Beef Checkoff amount increase, decrease or stay the same?"
[b]Approve: "Overall, do you approve or disapprove of the Beef Checkoff program?"
[c]The mean of each size category SZ_i was scaled by a factor of 1000 according the following schedule:

Size=.010:	SZ1=1-19
Size=.035:	SZ2=20-49
Size=.075:	SZ3=50-99
Size=.175:	SZ4=100-250
Size=.375:	SZ5=250-500
Size=.750:	SZ6=500-999
Size=1.50:	SZ7=>1000

Table 2. Probit Analysis of Firm Size

Size Category	coefficient	t-statistic
SZ1	-.4206**	(-2.39)
SZ2	-.7123***	(-4.31)
SZ3	-.5050***	(-3.10)
SZ4	-.6031***	(-3.62)
SZ5	-.2648	(-1.51)
SZ6	-.1420	(-0.69)
Constant	-1.0176***	(-6.58)

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 3. Bivariate Ordered Probit Results

Approval	coefficient	t-statistic
op1	0.00173	(0.01)
op2	-0.376***	(-2.77)
op3	-0.196	(-1.44)
op4	-0.157	(-0.97)
op5	-0.0890	(-0.41)
op6	0.250	(1.63)
op7	-0.0957	(-0.64)
gender	0.175***	(3.12)
age1	0.185***	(2.61)
age2	0.0556	(1.46)
age3	0.0780**	(2.02)
nso	0.0103	(0.27)
noco	0.0593	(1.16)
firm size	0.224***	(2.92)
Willingness to Pay	**coefficient**	**t-statistic**
op1	0.0511	(0.28)
op2	-0.141	(-0.73)
op3	0.0519	(0.27)
op4	-0.128	(-0.57)
op5	0.0252	(0.09)
op6	0.161	(0.81)
op7	-0.0594	(-0.29)
gender	0.0747	(1.00)
age1	0.306***	(3.48)
age2	0.0685	(1.50)
age3	0.0812*	(1.75)
noso	-0.0787*	(-1.65)
noco	0.0215	(0.34)
firm size	0.179**	(1.97)
cut21	-1.041***	(-5.24)
cut22	1.633***	(8.15)
ρ	0.6703	
Ho: $\rho = 0$	$\chi^2_{(1)} = 1365$	p-value=0.00001
N	5077	
Marginal effect of 10% increase in firm size on willingness to pay		
contract checkoff program		-0.41%
no change in checkoff program size		0.013%
expand checkoff program		0.58%

t statistics in parentheses

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$