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Incentives to Advertise and Product Differentiation

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Recent court rulings question the ability of commodity groups to fund generic promotions through mandatory check-off programs. A model examining incentives to fund brand advertisements when both brand and generic advertising exist is presented. Brand advertising expands the market by attracting new consumers to the industry, and allows the advertising firm to take customers from rivals in the industry. Homogeneous products are advertised too little relative to the amount that maximizes total industry profits, and brandable products are advertised too much. The optimal check-off rate is derived, and the Dorfman-Steiner condition is shown to be a special case of this model.

Key words: advertising, branding, check-off programs, commodity promotion

Introduction

There is ongoing debate about whether consumers face too much or too little advertising, and much theoretical work has examined the issue in differentiated goods industries.[1] The question is slightly different where advertising of agricultural commodities is concerned, because generic advertising does not directly benefit any single producer. Generic advertising is thus generally funded by some type of marketing order or commodity check-off program. Examples include programs funded by the National Pork Producers Council, the California Raisin Advisory Board, the National Cattlemen's Beef Association, and the Cotton Board, through Cotton, Inc. There is a large literature on these programs, although the papers do not directly address individual producer incentives to fund brand advertising when both brand and generic advertising may be conducted.[2] Until recently, this was not an issue, as funding of generic advertising programs, collected on a per unit basis from producers, was mandatory. With the recent Supreme Court ruling

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[1] Nelson; Bagwell and Ramey; and Milgrom and Roberts found there may be too little advertising in equilibrium, if ads serve to coordinate buyers and sellers, or if the fact of advertising signals product quality. In an early, well-known study of eyeglass advertising, Benham concluded advertising may increase competition and reduce prices paid by consumers. On the other hand, based on an analysis of the U.S. brewing industry, Tremblay and Tremblay report that if advertising is costly or uninformative, then equilibrium levels are excessive.

[2] See, for example, Freebairn and Alston; Piggott, Piggott, and Wright; Wohlgenant; Kinnucan, Xiao, and Hsia; Chung and Kaiser; Kaiser; Kinnucan and Miao; and Schmit, Reberte, and Kaiser. For book-length treatments of generic advertising, see Kinnucan, Thompson, and Chang; and Forker and Ward. Several studies have examined the benefits to farmers from advertising funded by mandatory check-off programs (see Zhang, Sexton, and Alston for a recent example), and thus indirectly considered when farmers would be willing to fund generic advertising, but the issue of private incentives in the presence of two types of advertising has yet to be addressed.

that mandatory funding of commodity promotion programs violates the First Amendment of the Constitution (*U.S. v. United Foods*), the issue of voluntary funding of both brand and generic advertising becomes more important.[3]

In this analysis, we ask whether individual producers would be willing to fund brand advertising in the absence of such a taxing authority. Generally speaking, the answer appears to be no, although our model contains some cases where voluntary funding would occur. These cases suggest what sorts of advertising campaigns could be voluntarily funded if mandatory funding is eliminated for other commodity-marketing programs.

The issue of brand advertising arises in several food markets. For example, Northland Cranberries left the Ocean Spray cooperative in 1993, and has enjoyed fairly rapid growth in sales of its branded juice products. An advertising campaign was launched in 1994, and the company obtained a double-digit market share in 1998. Evidently, as cranberry juice products have become differentiable, the incentive to fund brand advertising has increased, even as a federal marketing order for cranberries remains in place.[4] Another example involves the advertising campaign launched by Florida's Natural Growers (a citrus cooperative). As with cranberries, brand advertising has occurred even in the presence of a federal marketing order (with mandatory assessment) for Florida citrus. The incentives of these firms to fund brand advertising are likely to depend in large part on whether or not the product can be differentiated in the consumers' minds. Increased differentiability may lead to excessive advertising expenditures by competitors in these markets, even when generic advertising is funded through a check-off program.

This study considers two effects of advertising: (*a*) advertising may serve to attract new customers to the industry (the market-expansion effect), and (*b*) it may serve to attract customers from rival firms (the branding effect). When the main role of advertising is to expand the size of the market, additional advertising benefits all producers.[5] Although everyone benefits from such advertising, absent a taxing authority, only the advertising firm bears the cost, making incentives to advertise lower than optimal. On the other hand, incentives may be higher than optimal when individual advertising allows producers to differentiate (brand) their products, thereby taking customers from closely related products.

Alston, Freebairn, and James study this effect, which they call "beggar-thy-neighbor" advertising. In their model, brand advertising has two effects. First, it increases demand for the advertised product, while making competing goods less desirable and reducing demand for them (the direct effect).[6] Second, inasmuch as advertising increases the price of the advertised product, it increases demand for competing goods (the indirect effect). The net of these two effects is thus not theoretically determined, although Alston, Freebairn, and James demonstrate that advertising levels are higher when producer groups behave non-cooperatively than if they were to jointly maximize their industries' profits.

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[3] Crespi provides a good description of the legal debate surrounding mandatory check-off programs.

[4] Zhang, Sexton, and Alston consider the relationship between growers and processors in examining whether growers benefit from brand advertising. The issue here is whether the processors wish to fund brand advertising. The current study makes no claims regarding the benefits which may or may not accrue to growers.

[5] Indeed, Dixit and Norman (with supporting comments by Fisher and McGowan, and Shapiro) document that if advertising does not enlarge the size of the market, it reduces social welfare. Thus, society only benefits from advertising which expands the size of the market.

[6] Given a fixed budget for the commodity group in question, this "direct" effect is a consequence of the adding-up condition described in Basmann.

What we call the "branding effect" occurs when advertising allows a producer to increase sales at the expense of producers of closely related products. Given that each consumer has a fixed budget for the industry's products, this branding is a consequence of the adding-up condition described in Basmann—advertising influences consumer preferences in a way that increases a firm's sales at the expense of its rivals. This branding effect is similar to the direct effect of Alston, Freebairn, and James, or the spillover effect of Kinnucan, although their models assessed competition between industries, while we describe competition among firms in a single industry.

As shown below, incentives to advertise depend on the strength of this direct effect. This, in turn, depends on the degree to which consumers view the two commodities as substitutes for each other. In both Alston, Freebairn, and James, and Kinnucan, Xiao, and Hsia, products within a single industry (beef, for example), could not be differentiated from one another; thus, the direct (or spillover) effect occurs only between industries. However, if products within a single industry can be branded, then the competitive equilibrium number of industry ads may be larger than that which would maximize industry profits. Kinnucan, Xiao, and Hsia describe the effect of increased beef promotion on the demand for chicken and pork, although their model does not include the market-size effect, and they do not directly consider incentives to fund advertising. Their findings show that beef advertising appears to harm mainly poultry producers.

In the model presented here, the market-size effect represents an externality created by the advertising producer for all competitors in the industry. If the main effect of advertising is to expand the market, then the competitive equilibrium level of advertising is below the level which would maximize industry profits. In the limiting cases, incentives to advertise are too weak when products cannot be branded, and too strong when they are perfectly differentiable. That is, advertising for commodities (which cannot be differentiated) is lower, and advertising for branded products is higher, than the levels which maximize industry profits.

After examining the effect of a firm's own advertising, the effect of competitors' advertisements is reviewed. Ads are substitutes when products cannot be branded (i.e., only the market-size effect is present), because advertising increases all firms' profits, whether or not they contributed to it. Consequently, an advertisement by firm j is viewed by firm i as equivalent (and less expensive) than an ad funded by firm i. On the other hand, if advertising allows producers to take sales from related products, then ads may be complements, so that rival advertisements reduce own profit. In this case, an additional ad by firm j increases the incentive for firm i to fund another advertisement, in order to maintain its customer base. Producers would be better off if their rivals advertised less when taking business from competitors is possible.

The Model

Consider a monopolistically competitive industry with n firms. None of them have market power per se, but the goods are differentiable, which makes the demand curve faced by each firm downward sloping, where the degree of differentiability (δ) determines the "steepness" of each firm's demand curve. Each firm's profit is given by $\pi_i = s_i P(A, Q)Q - c(a_i, X) - tq_i$, where Q is the amount of the food product (commodity)

being sold, and s_i is the firm's share of industry net revenue $P(A, Q)Q$.[7] $P(A, Q)$ gives demand, which depends on total industry advertising (A) as well as on the amount of Q exchanged in the market. Industry advertising is defined by $A = tQ + \Sigma a_i = tQ + \alpha$, where tQ is generic advertising funded through a mandatory check-off program, a_i is brand advertising paid for by each firm individually, and α is the total amount of brand advertising done in the industry.

This specification suggests mandatory advertising depends on how much of the commodity is sold, while brand advertising is chosen individually by each producer. Many check-off programs operate in this way. For now, the simplifying assumption that t is chosen independently of a_i will be maintained. Later, this assumption is relaxed, and t is allowed to depend on total industry advertising A. Profits are reduced by the cost of production and advertising, $c(a_i, X)$ (where X represents inputs other than advertising), as well as by the check-off funding sent to the industry group (tq_i).

The firm's share of industry revenue (s_i) depends on the structure of the industry in two ways. First, assuming customers search randomly for products, each of the n firms should receive $1/n$th of the industry's customers. Depending on the degree of differentiability (δ) between products in the industry, each firm will sell $1/n$th of industry output. As noted, though, if goods can be differentiated, firms may not sell equal amounts. In particular, a firm's sales are also assumed to depend on its share of brand advertising (where the effectiveness of brand advertising depends on the degree of differentiability of goods in the market). Thus, each firm's share of industry profits is given by:

$$s_i = (1 - \delta)\frac{1}{n} + \delta\frac{a_i}{A}, \quad 0 \le \delta \le 1, \tag{1}$$

so that

$$\pi_i = \left[(1 - \delta)\frac{1}{n} + \delta\frac{a_i}{A}\right]P(A, Q)Q - c(a_i, X) - tq_i. \tag{2}$$

Profits for firm i thus depend on the effects of industry advertising on revenue $P(A, Q)Q$, and on the (exogenously given) degree to which products in the industry can be branded (δ).

A note on δ is in order here. The focus of this study is on the incentives of individual firms in a single industry to engage in brand advertising a_i above and beyond the amount they are required to contribute to generic advertising campaigns (tq_i). The more the industry's products can be differentiated, the larger is δ, and the more sensitive is each firm's profit to its own share of industry brand advertising. The polar cases of complete homogeneity ($\delta = 0$) and ensured branding ($\delta = 1$) are analyzed in this study. Intermediate cases, while interesting and perhaps more realistic, do not allow for comparisons to existing literature in which δ is assumed to be zero. A value of $\delta = 0.5$ suggests that while some branding is possible, a firm is not guaranteed that its brand advertisements distinguish its product in the minds of consumers. Specifically, the good in question can be differentiated, but attempts to do so may not be well understood or received by consumers. Thus, while Vidalia onions are a well-recognized brand, Cal-Organic potatoes may not enjoy the same level of recognition.

[7] The revenue of firm i depends on total industry sales Q, rather than on individual output q_i. The dependence of profits on q_i is suppressed in this model in order to examine the effects of advertising.

Degree of differentiability is exogenous to this model, and depends on the product being sold. For example, some commodities may be differentiable based on where they are grown (e.g., Washington apples or Vidalia onions), while others are not (e.g., celery). This suggests a higher δ for apples and onions than for celery, due to factors outside the scope of this model. It would be interesting to examine the factors influencing δ, particularly as they relate to agricultural commodities, and to see how degrees of differentiability change over time. However, this work would complicate the present model, and thus must be relegated to a future research project.

When products cannot be differentiated ($\delta = 0$), each firm takes its share of the market as given, and its profit depends only on the number of firms in the industry. Advertising done by any one firm does not affect its share of market revenue, and the firm's profit function is denoted by

$$\pi_i^h = \frac{1}{n} P(A, Q)Q - c(a_i, X) - tq_i,$$

where h stands for homogeneous, as consumers are assumed to view the output of any one firm in the industry as identical to that of any other firm.

Assuming, for simplicity, that the n firms in the industry are identical in size, each of them receives an equal share of industry revenue. To ensure a finite level of advertising, the following assumptions regarding the shape of the demand and cost curves will be maintained:

$$\partial P/\partial A = P_A > 0, \quad \partial^2 P/\partial A^2 = P_{AA} \leq 0, \quad \text{and} \quad \partial c/\partial a_i = c_a > 0.$$

These assumptions guarantee that revenue increases with advertising, but at a decreasing rate, and that increasing marginal costs will eventually rise to the level of marginal revenue. In this market, firm i's revenue depends on total industry advertising and the number of competitors in the industry.

If products are completely differentiable ($\delta = 1$), advertising for product i always causes consumers to believe the good is distinct and better than the products available from competitors. In this case, the firm's profit function is given by

$$\pi_i^d = \frac{a_i}{A} P(A, Q)Q - c(a_i, X) - tq_i,$$

where d stands for differentiated (or differentiable), as products are assumed to be. One may wonder, in this case, why generic advertising is necessary. Inasmuch as it expands the size of the market, through its effect on demand $P(A, Q)$, individual firms benefit from both generic and brand advertising.

When products can be differentiated, firm i's revenue depends both on total industry advertising and on its share of that total. Advertising then has two effects. First, when firm i funds additional brand advertising, it is able to attract customers who formerly went to competitors. This branding effect arises when additional ads by firm i increase its share of α (total brand advertisements), so that $d/da_i(a_i/A) = [1 - a_i d\alpha/A da_i]/A$ is positive.[8] The second effect of advertising is the market expansion effect, which occurs when firm i's advertising increases total industry advertising and thus attracts new

[8] Recall, because t does not depend on α, $dA/da_i = d\alpha/da_i$. Also note that $d\alpha/da_i = \Sigma\, da_j/da_i$.

consumers. Given that $\partial P/\partial A > 0$, all groups in the industry benefit from a positive market-expansion effect, which occurs as long as $d\alpha/da_i > 0$.

Notice that when market expansion fails, $d\alpha/da_i \leq 0$, the branding effect is definitely positive. If brand ads funded by firm i are offset by fewer rival ads, then firm i's revenue rises because it is taking existing customers from rival firms (without increasing the number of customers purchasing in the industry). Also note branding is harder for firms already doing a large share of industry advertising—i.e., as a_i/A grows, $(d/da_i)(a_i/A)$ shrinks. For firms already doing most of an industry's advertising, it is difficult to take business from their rivals through additional advertisements.

Finally, total profit earned by the industry is specified as follows:

$$\text{(3)} \qquad \Pi = \sum_i \pi_i = \sum_i \left\{\left[(1-\delta)\frac{1}{n} + \delta\frac{a_i}{A}\right]P(A,Q)Q - c(a_i, X) - tq_i\right\}$$
$$= P(A,Q)Q\left[(1-\delta) + \delta\frac{\alpha}{A}\right] - \sum_i c(a_i, X) - tQ.$$

Incentives to Advertise

To determine the effect of an increase in advertising on firm i's profit, and recalling the maintained assumption that t is chosen independently of a_i, the following first-order condition is used:

$$\text{(4)} \qquad \frac{d\pi_i}{da_i} \equiv \left[(1-\delta)\frac{1}{n} + \delta\frac{a_i}{A}\right]Q\frac{\partial P}{\partial A}\frac{dA}{da_i} + \delta\frac{PQ}{A}\left[1 - \frac{a_i}{A}\frac{dA}{da_i}\right] - \frac{dc}{da_i} = 0.$$

Firm i maximizes its profit by setting $d\pi_i/da_i = 0$, which implies it advertises until the marginal cost of its own advertising, dc/da_i, is equal to its share of incremental industry revenue from advertising. Notice this equilibrium condition contains both the demand-expanding effect $(\partial P/\partial A)(dA/da_i)$ and the branding effect $(1 - a_i dA/Ada_i)$. When products are not differentiable ($\delta = 0$), only the market expansion effect is present, but when products are completely differentiable ($\delta = 1$), both the market expansion and branding effects can be observed. For intermediate cases [$\delta \in (0, 1)$], both of these effects will be present to varying degrees.

From the industry's point of view, the effects of an additional advertisement by firm i on all industry members must be considered. Let a_i^* be the (optimal) level of advertising that satisfies the following equilibrium condition:

$$\text{(5)} \qquad \frac{d\Pi}{da_i} \equiv (1-\delta)Q\frac{\partial P}{\partial A}\frac{dA}{da_i} + \frac{\delta PQdA/da_i}{A}\left[\frac{\alpha}{P}\frac{\partial P}{\partial A} + 1 - \frac{\alpha}{A}\right] - \sum_j \frac{\partial c}{\partial a_j}\frac{da_j}{da_i} = 0.$$

Collecting terms gives

$$\frac{d\Pi}{da_i} \equiv \left[1 - \delta\left(\frac{A-\alpha}{A}\right)\right]\frac{\partial P}{\partial A}\frac{dA}{da_i}Q + \delta\frac{PQ}{A}\frac{dA}{da_i}\left(\frac{A-\alpha}{A}\right) - \sum_j \frac{\partial c}{\partial a_j}\frac{da_j}{da_i} = 0,$$

where the demand-expanding effect appears in the first term, and the branding effect in the second term. The branding effect is slightly different here, as the industry considers the effect of firm i's advertising on the profits of all firms in the industry, not just the effect on firm i.

As δ approaches zero, the branding effect disappears while the demand-expanding effect does not. In contrast, as δ approaches one, the branding effect becomes more important, while the significance of the demand expansion effect shrinks. The share of generic advertising in total advertising $(A - \alpha)/A$ also influences the effect of firm i's brand advertising on total industry profit. For a given level of differentiability, a larger generic share increases the importance of the branding effect $[\delta PQ(dA/da_i)/A]$, and reduces the influence of the demand-expanding effect $(\partial P/\partial A)(dA/da_i)$. This reduction in the demand-expanding effect illustrates declining marginal productivity—the marginal brand advertisement is more effective when fewer ads exist.

If products are homogeneous, $\delta = 0$, and the individual firm's first-order condition [equation (4)] reduces to

$$\frac{d\pi_i}{da_i} \equiv Q\frac{1}{n}\frac{\partial P}{\partial A}\frac{dA}{da_i} - \frac{dc}{da_i} = 0. \tag{6}$$

Given the assumptions regarding the shape of $P(A, Q)$ and $c(a_i, X)$, this condition is satisfied by some finite level of advertising a_i^h, where the h denotes "homogeneous."[9]

From the industry's point of view, firm i's advertising level should be set to satisfy

$$\frac{d\Pi}{da_i} \equiv Q\frac{\partial P}{\partial A}\frac{dA}{da_i} - \sum_j \frac{dc}{da_j}\frac{da_j}{da_i} = 0. \tag{7}$$

Assuming $dc/da_i = dc/da_j = dc/da$, and substituting the value of dc/da from equation (6) into equation (7), it is possible to evaluate the industry first-order condition at the equilibrium outcome a_i^h. This gives:

$$\left.\frac{d\Pi}{da_i}\right|_{a_i^h} = Q\frac{\partial P}{\partial A}\frac{dA}{da_i}\left(1 - \frac{1}{n}\sum_j \frac{da_j}{da_i}\right) = \frac{dc}{da}\left(n - \sum_j \frac{da_j}{da_i}\right). \tag{8}$$

In either version of this expression, the equilibrium level of advertising by firm i (a_i^h) is optimal (equal to a_i^*, which maximizes industry profits) only when competitors on average choose to match firm i's advertising expenditure dollar for dollar $[(1/n)\Sigma(da_j/da_i) = 1]$. If the response to an additional advertisement by firm i is not an equally costly advertisement by i's competitors, making $(1/n)\Sigma(da_j/da_i)$ smaller than one, then the equilibrium level of advertising (a_i^h) is lower than the optimal level (a_i^*), since at a_i^h, $d\Pi/da_i > 0$.

Thus, when products cannot be differentiated, and given reasonable assumptions regarding the response of competitors to increased advertising by firm i, industry profits could be increased if there were more brand advertising than is privately optimal. This

[9] As products cannot be differentiated, a_i^h is likely to be small, or even zero. However, advertisements may be funded if the benefit caused by expanded demand $Q(\partial P/\partial A)(dA/da_i)$ is n times larger than the marginal cost of the ad, dc/da_i. Specifically, if the effect on demand is large enough, firm i may find it worthwhile to engage in individual advertising, even when branding is not possible. Such advertising is most likely for products which have been newly developed and have rapidly expanding markets, such as enoki or shiitake mushrooms.

is so because brand advertisements increase the size of the market without directly increasing sales for the advertising firm. The firm accounts for the latter effect (increased sales), but not the former (market expansion) in its decisions regarding how much to advertise. Hence, the public good of market expansion is underprovided.[10]

Alternatively, if goods are easily differentiated ($\delta = 1$), then each firm's chosen level of output, a_i^d, will solve:

$$\frac{d\pi_i}{da_i} \equiv \frac{a_i Q}{A}\frac{\partial P}{\partial A}\frac{dA}{da_i} + \frac{PQ}{A}\left(1 - \frac{a_i}{A}\frac{dA}{da_i}\right) - \frac{dc}{da_i} = 0, \tag{9}$$

while, from the industry's point of view, assuming (as before) that $dc/da_i = dc/da_j = dc/da$, the optimal level of advertising by firm i satisfies

$$\frac{d\Pi}{da_i} \equiv Q\frac{\alpha}{A}\frac{\partial P}{\partial A}\frac{dA}{da_i} + \left(\frac{A-\alpha}{A}\right)\frac{PQ}{A}\frac{dA}{da_i} - \frac{dc}{da}\frac{d\alpha}{da_i} = 0. \tag{10}$$

From equation (9), at a_i^d, $dc/da_i = dc/da = (a_i Q/A)(\partial P/\partial A)(dA/da_i) + (PQ/A)(1 - a_i dA/A da_i)$, where the first equality comes by assumption, and the second from the first-order necessary conditions for profit maximization. Substituting this value of dc/da_i into equation (10) gives:

$$\begin{aligned}\left.\frac{d\Pi}{da_i}\right|_{a_i^d} &= \frac{dA}{da_i}\frac{PQ}{A}\left[\frac{\partial P}{\partial A}\frac{A}{P}\left(\frac{\alpha}{A} - \frac{a_i}{A}\frac{dA}{da_i}\right) - \frac{\alpha}{A} + \frac{a_i}{A}\frac{dA}{da_i}\right] \\ &= \frac{dA}{da_i}\frac{PQ}{A}\left[\frac{\partial P}{\partial A}\frac{A}{P}\left(\frac{\alpha - a_i dA/da_i}{A}\right) + \frac{a_i dA/da_i - \alpha}{A}\right].\end{aligned} \tag{11}$$

It is straightforward to show that $d\Pi/da_i|_{a_i^d}$ is negative if

$$\frac{\partial P}{\partial A}\frac{A}{P}\left(\frac{\alpha - a_i dA/da_i}{A}\right) < \frac{\alpha - a_i dA/da_i}{A} \quad \Leftrightarrow \quad \frac{\partial P}{\partial A}\frac{A}{P} < 1. \tag{12}$$

Because the advertising elasticity of demand $(\partial P/\partial A)(A/P)$ is almost certainly less than unity, it is certain that $d\Pi/da_i|_{a_i^d}$ is negative, thereby implying industry profits would improve if firm i's advertisements were reduced below their equilibrium level. When the market-expanding effect is small, very few (if any) brand advertisements are optimal. Firms continue to advertise, however, because of the possibility of attracting customers from rivals and because advertising is necessary to avoid having customers stolen by competitors. As long as a 1% increase in brand advertising leads to a smaller than 1% increase in the price of the good being advertised, firms in the industry would do better if each of them cut its advertising. However, the presence of the branding effect gives firms incentive to advertise, i.e., they can attract customers from a competitor and/or avoid having customers taken by an advertising competitor.

This result suggests, for example, the Florida's Natural Growers cooperative may be spending more on advertising than is beneficial for the citrus industry taken as a whole,

[10] This is closely related to the free-rider problem in funding generic advertising. Here, generic advertising is automatically funded. Because brand advertisements have a similar effect on demand, they are underprovided from the industry's viewpoint.

in order to increase its own share of the orange juice market. Similarly, Northland Cranberries' funding of brand advertising, while benefiting Northland Cranberries, may actually cause total profits in the cranberry juice market to be lower than they could otherwise be. Advertising causes demand to shift from one producer to another, but does not expand the market.

Dorfman and Steiner, in their seminal paper on advertising, derive a similar condition regarding the equilibrium level of advertising, although in a different context. The same condition is derived by Freebairn and Alston in a model similar to the one presented here. Neither of these models considers the two types of advertising posited here (brand and generic), and thus cannot address the question of whether brand advertising is excessive or insufficient. Both papers show that when the equilibrium advertising level is nonzero, the marginal value product of advertising ($Q\partial P/\partial A$) equals the own-price elasticity of demand, $\eta = (-\partial Q/\partial P)(P/Q)$. Multiplying both sides of this equality by A/PQ, the optimal advertising-sales ratio yields:

$$Q\frac{\partial P}{\partial A}\frac{A}{PQ} = \eta\frac{A}{PQ} \quad \Rightarrow \quad \frac{\partial P}{\partial A}\frac{A}{P} = \eta\frac{A}{PQ}. \tag{13}$$

Equation (13) states that at the equilibrium level of advertising, the advertising elasticity of demand is equal to the price elasticity of demand times the advertising-sales ratio. Equation (12) shows the equilibrium level of advertising is larger than optimal when demand is inelastic with respect to brand advertising. Tying the two equations together reveals how the size of the price elasticity of demand also affects the comparison between equilibrium and optimal advertising levels. Given that the advertising-sales ratio is less than one, as long as demand is not too elastic with respect to price, demand will be inelastic with respect to brand advertising, and producers will advertise more than is optimal.

Industry Group Incentives, Effective Advertisements, and the Optimal Check-off Rate

Next, the influence of the tax charged by the industry group is considered. The industry group may choose t to ensure generic advertising is effective by setting t to make $d\Pi/dA = 0$. Recall, industry profits are given by $\Pi = PQ[(1-\delta) + \delta\alpha/A] - \Sigma c(a_i, X) - tQ$. Thus,

$$\begin{aligned}\frac{d\Pi}{dA} &\equiv \frac{\partial P}{\partial A}Q\left[(1-\delta) + \delta\frac{\alpha}{A}\right] - PQ\delta\frac{\alpha}{A^2} \\ &= (1-\delta)\frac{\partial P}{\partial A}Q + \delta\frac{\alpha Q}{A}\left[\frac{\partial P}{\partial A} - \frac{P}{A}\right] = 0.\end{aligned} \tag{14}$$

When goods cannot be differentiated ($\delta = 0$), equation (14) reduces to $Q\partial P/\partial A = 0$. That is, generic advertising is effective as long as advertising (both brand and generic) expands the market. Once this market expansion effect disappears ($\partial P/\partial A = 0$), funding additional advertising does not increase industry profits.

When goods can be differentiated ($\delta = 1$), equation (14) reduces to $Q\alpha/A(\partial P/\partial A - P/A) = 0$. In this case, advertising is effective as long as $\partial P/\partial A \geq P/A$, or $(\partial P/\partial A)(A/P) \geq 1$. As noted earlier, this inequality is unlikely to ever hold, suggesting advertisements of

either type are probably ineffective. In turn, this implies the optimal check-off rate (t) when products are differentiable ($\delta = 1$) is probably zero.

The tax rate will be lower when branding is effective ($\delta = 1$), as more generic advertisements are required to cause the demand-expanding effect $\partial P/\partial A$ to fall to zero than to cause it to fall to some positive number. As branding of food products becomes possible, industry groups should fund fewer (or perhaps no) advertisements and have a smaller check-off rate. Notice also that as long as the check-off rate is set to ensure advertising is effective, there will not be excessive brand advertisements in equilibrium. Firms will fund brand advertising, but the check-off rate will adjust to account for the market-expanding effect of brand advertising. However, in order to ensure advertising is effective (rather than excessive), industry groups may need to regularly adjust their generic advertising strategies, as well as the rate at which producers are taxed to fund generic advertising. If the check-off rate adjusts only slowly, and products are differentiable, the level of advertising may be excessive.

The optimal check-off rate can be examined in a slightly different way by following the technique proposed by Dorfman and Steiner, which defines the optimal check-off rate as that which sets $d\Pi/dt = 0$. Rather than defining the rate indirectly through advertising (A), and attempting to ensure advertising remains effective, Dorfman and Steiner (and Freebairn and Alston in a slightly different context) calculate the optimal rate directly, thereby establishing that an adjustment to the check-off rate cannot further increase industry profits. It can be shown that

$$\text{(15)} \qquad \frac{d\Pi}{dt} = Q\left[(1-\delta) + \delta\frac{\alpha}{A}\right]\frac{dP}{dt} + P\left[(1-\delta) + \delta\frac{\alpha}{A}\right]\frac{dQ}{dt} + PQ\delta\frac{d}{dt}\left(\frac{\alpha}{A}\right) - \sum_i \frac{dc}{da_i}\frac{da_i}{dt} - Q - t\frac{dQ}{dt}.$$

Since $A = \alpha + tQ$, we know that $dA/dt = d\alpha/dt + Q + tdQ/dt$. If, as is assumed in Freebairn and Alston, the amount sold in this market is derived from retail demand, then $dQ/dt = 0$; therefore, $dA/dt = d\alpha/dt + Q$, and $(d/dt)(\alpha/A) = (d\alpha/dt)/A - \alpha(d\alpha/dt + Q)/A^2$. Thus,

$$\frac{d\Pi}{dt} = Q\left[(1-\delta) + \delta\frac{\alpha}{A}\right]\frac{dP}{dt} + PQ\delta\frac{d}{dt}\left(\frac{\alpha}{A}\right) - \sum_i \frac{dc}{da_i}\frac{da_i}{dt} - Q.$$

Furthermore, $dP/dt = (\partial P/\partial A)(dA/dt) + (\partial P/\partial Q)(dQ/dt) = (\partial P/\partial A)(dA/dt)$, so that

$$\text{(16)} \qquad \frac{d\Pi}{dt} = (1-\delta)Q\frac{\partial P}{\partial A}\frac{dA}{dt} + \delta\frac{PQ}{A}\left(\frac{\alpha}{P}\frac{\partial P}{\partial A}\frac{dA}{dt} + \left[\frac{A-\alpha}{A}\right]\frac{d\alpha}{dt} - \frac{\alpha Q}{A}\right) - \sum_i \frac{dc}{da_i}\frac{da_i}{dt} - Q.$$

When products cannot be differentiated ($\delta = 0$), and assuming the marginal cost of advertising is the same for each firm, so that $\Sigma(dc/da_i)(da_i/dt) = (dc/da)(d\alpha/dt)$, this equation reduces to

$$\frac{d\Pi}{dt} = Q\frac{\partial P}{\partial A}\frac{dA}{dt} - \frac{dc}{da}\frac{d\alpha}{dt} - Q = Q\frac{\partial P}{\partial A}\left(\frac{d\alpha}{dt} + Q\right) - \frac{dc}{da}\frac{d\alpha}{dt} - Q.$$

As products cannot be differentiated, the optimal level of brand advertising (α) can be safely assumed to be zero, which makes $d\alpha/dt$ also zero. Thus, if the industry chooses its tax rate to set $d\Pi/dt = 0$, it must set $Q^2(\partial P/\partial A) = Q$, which implies $Q(\partial P/\partial A) = 1$, or

$$\frac{\partial P}{\partial A}\frac{A}{P} = \frac{A}{PQ}. \tag{17}$$

This finding is similar to results derived by both Dorfman and Steiner, and Freebairn and Alston in settings in which there was only a single type of advertising. As in these earlier studies, when the only role of advertising is to expand the market, the advertising intensity (A/PQ) should be set to equal the advertising elasticity of demand $(\partial P/\partial A)(A/P)$.

When products are perfectly differentiable ($\delta = 1$), it can be shown that the optimal check-off rate is zero. Equation (16) becomes

$$\frac{d\Pi}{dt} = \frac{PQ}{A}\left[\frac{\alpha}{P}\frac{\partial P}{\partial A}\frac{dA}{dt} + \left[\frac{A-\alpha}{A}\right]\frac{d\alpha}{dt} - \frac{\alpha Q}{A}\right] - \frac{dc}{da}\frac{d\alpha}{dt} - Q.$$

Setting this derivative equal to zero yields

$$\frac{\alpha}{P}\frac{\partial P}{\partial A}\left(\frac{d\alpha}{dt} + Q\right) + \left(\frac{A-\alpha}{A}\right)\frac{d\alpha}{dt} - \frac{\alpha Q}{A} - \frac{A}{PQ}\left[\frac{dc}{da}\frac{d\alpha}{dt} + Q\right] = 0,$$

so that

$$\left(\frac{d\alpha}{dt} + Q\right)\left(\frac{\alpha}{P}\frac{\partial P}{\partial A} - \frac{\alpha}{A}\right) + \frac{d\alpha}{dt} - \frac{A}{PQ}\left[\frac{dc}{da}\frac{d\alpha}{dt} + Q\right] = 0,$$

or

$$\frac{\alpha}{A}\left(\frac{d\alpha}{dt} + Q\right)\left(\frac{A}{P}\frac{\partial P}{\partial A} - 1\right) = \frac{A}{PQ}\left[\frac{dc}{da}\frac{d\alpha}{dt} + Q\right] - \frac{d\alpha}{dt}.$$

The left-hand side of this equation gives the marginal benefit to increasing the check-off rate, while the right-hand side is the marginal cost. Given that an increase in the check-off rate does not reduce total advertising expenditures, so that $d\alpha/dt + Q$ is positive, it becomes clear that as long as demand is inelastic with respect to advertising [i.e., $(A/P)(\partial P/\partial A) < 1$], the marginal benefit to increasing the tax rate is negative. The marginal cost, on the other hand is positive. The optimal check-off rate (t), then, is zero. When products are completely differentiable, the industry group does best by relying on brand advertising to expand the size of the market, rather than requiring members to fund generic advertising. Needless to say, this conclusion has far-reaching policy implications for many agricultural markets, and suggests, at a minimum, marketing orders need to be reviewed on a regular basis to assure they cover only products where differentiation is difficult.

The Effect of Rival Advertising on Profits

To reinforce these conclusions regarding industry optimum levels of advertising, the effect of ads created by firm j on firm i's profits is examined. To do this, one must calculate the following:

$$(18)\qquad \frac{d\pi_i}{da_j} = \left[(1-\delta)\frac{1}{n} + \delta\frac{a_i}{A}\right]Q\frac{\partial P}{\partial A}\frac{dA}{da_j} + \frac{\delta PQ}{A}\left[\frac{da_i}{da_j} - \frac{a_i}{A}\frac{dA}{da_j}\right]$$
$$= (1-\delta)\frac{Q}{n}\frac{\partial P}{\partial A}\frac{dA}{da_j} + \delta Q\left[\frac{a_i}{A}\frac{\partial P}{\partial A}\frac{dA}{da_j} + \frac{P}{A}\left(\frac{da_i}{da_j} - \frac{a_i}{A}\frac{dA}{da_j}\right)\right].$$

When products cannot be differentiated ($\delta = 0$), we have

$$\frac{d\pi_i}{da_j} = \frac{Q}{n}\frac{\partial P}{\partial A}\frac{dA}{da_j},$$

which is positive as long as rival brand advertising does not fall when firm j funds another advertisement ($dA/da_j \geq 0$). Thus, firm i's profit rises as firm j's advertising increases. Because the only effect of advertising when products cannot be differentiated is market expansion, all advertising for which it pays nothing benefits firm i. In fact, other things equal, funding by firm j benefits firm i more than firm i's own funding, as the effect on revenue is the same but the cost is borne by someone else.

When products can be differentiated, both the market-expansion effect and the branding effect are observed. In this case (when $\delta = 1$), and noting at the optimum a_i, $da_i/da_j = 0$, we have:

$$(19)\qquad \frac{d\pi_i}{da_j} = Q\frac{a_i}{A}\frac{dA}{da_j}\left[\frac{\partial P}{\partial A} - \frac{P}{A}\right],$$

which is negative, given the reasonable assumption that $(\partial P/\partial A)(A/P) < 1$. As long as demand is inelastic with respect to advertisements (which is a generally accepted conclusion), firms are engaging in excessive brand advertising, and an additional brand advertisement by firm j will not increase price enough to increase the profits of firm i. Instead, firm j's ad allows it to take business from firm i, thereby reducing i's profits. Here, the branding effect outweighs the industry expansion effect, and additional ads by firm j reduce i's profit.

Notice the close relationship between equation (19) and the condition regarding the optimal level of industry advertisements given in equation (12). Not surprisingly, when firms engage in excessive brand advertising, each firm harms its competitors (and indirectly itself) when it funds additional brand advertising.

Conclusion

This study has examined the incentives of private groups to fund advertising for agricultural products. Advertising has two effects. First, it may expand the market, thus increasing the profits of all firms in the industry. Second, it may induce customers of one firm to purchase from a competing firm instead. This branding effect is present only when products can be differentiated. When branding is not possible, individual firm incentives to advertise are too low, and fewer ads than would maximize industry profit are produced. This explains why many agricultural industries include cooperatives and check-off programs to purchase generic advertising designed to expand the market. It is not because producers are unable to advertise for themselves, but because they rationally refuse to do so, knowing they will not recover the entire cost of their advertisements.

In differentiated-products industries, the possibility of increasing sales at the expense of competitors in addition to attracting new customers to the industry implies brand advertising has two profit-enhancing effects for an individual firm. This possible increase in sales raises the incentive of the firm to advertise, without increasing the socially optimal level of advertising (which depends only on the demand-expanding effect). The end result is that the privately optimal level of advertising is too large.

The industry group's optimal tax rate is then derived. When products cannot be differentiated, the tax rate is set so that the last generic advertisement funded does not affect market price. The industry group attempts to capture all market-expansion effects. In industries where branding is possible, ads expand the market as long as a 1% increase in generic advertisements raises market price by 1%. Because generic advertising elasticity is generally much smaller than unity, and because both generic and brand advertising elasticities are smaller than the price elasticity of demand (as predicted by the Dorfman-Steiner theorem), ads rarely expand the market when branding is possible. Further, brand advertising will also be conducted in equilibrium, and therefore the industry group need not bear the cost of market expansion. In short, as branding of agricultural products becomes possible, the optimal check-off rate should fall. In fact, it is possible to show that when branding is effective, the industry group should stop funding generic advertising.

The effect of an increase in firm j's advertising level on firm i's optimal choice of advertising is then considered. In homogeneous-goods industries, an increase in firm j's advertising level is found to increase the profit of firm i. That is, ads are substitutes for one another. In differentiated-goods industries, an increase in firm j's advertising level likely reduces the profits of firm i. This makes ads complements, suggesting an additional advertisement funded by firm j causes firm i to increase its own level of advertising as well.

This study does not make claims regarding socially optimal levels of advertising, because it does not consider consumer welfare. In both types of industries, the privately optimal level of advertising is not likely to maximize social welfare, as it does not even maximize industrywide profits. Further results are difficult to obtain without examining the effects of advertisements on consumer utility.

Extensions of this work might examine the effect of mergers on incentives to advertise, or the factors influencing the degree of differentiability of products, and how this differentiability changes over time. When two firms merge, their share of industry advertising will (at least initially) rise. Depending on specific assumptions about how final shares adjust, one may see larger or smaller incentives to advertise, which may increase or reduce social welfare. As agricultural products become increasingly "brandable," it becomes important to gain a better understanding of what lies behind the δ term used here, especially as this relates to agricultural commodities. A more thorough understanding of branding possibilities has the potential to benefit both processors and producers of agricultural goods.

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