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COORDINATION IN MARKETS WITH CONSUMPTION EXTERNALITIES: THE ROLE OF ADVERTISING AND PRODUCT QUALITY

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COORDINATION IN MARKETS WITH CONSUMPTION EXTERNALITIES: THE ROLE OF ADVERTISING AND PRODUCT QUALITY

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ABSTRACT

Coordination in Markets with Consumption Externalities: The Role of Advertising and Product Quality*

This paper studies advertising in vertically differentiated product markets with positive consumption externalities. In markets with consumption externalities, the value of the product to the consumer depends on the purchasing decisions of other consumers. In such markets, we show that firms will engage in advertising competition in order to convince consumers of their popularity only as long as they produce goods of similar quality. The firm with the lower quality product will have a greater incentive to advertise. If it is not the brand to provide the greater consumption externality it will have very low market share due to its low intrinsic quality. Hence, in equilibrium, the lower quality product will often be more popular. This provides an additional explanation for the empirical observation that in some markets high quality is associated with lower levels of advertising.

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I. INTRODUCTION

This paper aims to improve understanding of advertising in markets with consumption externalities. We show that even when products are vertically differentiated, firms may engage in advertising competition in order to convince the consumers of their popularity. There is a natural sense in which consumers will tend to neglect product quality in favor of advertising when making conjectures about which product will be more popular. This incentive survives as long as the firms' product qualities are not drastically different from each other. The firm with the lower quality product will have a greater incentive to advertise. If it is not the brand to provide the greater consumption externality it will have very low market share due to its low intrinsic quality. Hence, in equilibrium, the lower quality product will often be more popular. This provides an additional explanation for the empirical observation that in some markets high quality is associated with lower levels of advertising.

In markets with consumption externalities, the value of the product to the consumer does not only depend on the characteristics of the product but it also depends on the purchasing decisions of other consumers either due to social interaction or due to network externalities; An evening out may be more enjoyable at a popular pub. Reading a best seller gives the additional pleasure of having common conversation topics with other people. The decision about which software to purchase is probably not only determined by the relative prices or qualities of the competing packages. It is very likely that the choice also involves the expectations about which one of the software packages is going to be more widely adopted. The more widely adopted packages have more compatible products developed. The users of widely adopted systems have more people around that can help with trouble shooting.

In such markets, Pastine and Pastine (2002) show that firms may advertise in order to coordinate consumer expectations on their own brand. While the firm has incentives to advertise to convince the consumer that its brand will be the popular one, it is also rational for the individual consumer to use advertising as a coordination device. When the consumer observes an expensive advertising campaign by a firm, the consumer realizes that the firm would not have advertised if it did not expect advertising to increase its sales. Hence it is in the best interest of the individual to purchase the heavily advertised brand, vindicating the advertising investment of the firm. Clark and Horstmann (2005) show that advertising as a coordination device survives in equilibrium also in a more realistic environment where consumers imperfectly observe the advertising spending of the firms.

While Pastine and Pastine (2002) analyze a market with homogenous products and identical consumers, in this paper we allow for different qualities and the consumers differ in their taste for the product. We investigate whether advertising can serve a coordinating function when goods are of different qualities. When advertising serves a coordinating function, we examine the nature of the advertising competition.

In order to focus on the coordinating role of advertising in markets with vertically differentiated products we construct a model which abstracts from previously analyzed roles for advertising. To abstract from the "persuasive role" of advertising [1] we assume that consumers are rational and that their preferences are constant in the face of advertising. To abstract from the "informative role" of advertising we assume common knowledge of the existence, prices and

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[1]See Galbraith (1967), Solow (1967), Dixit and Norman (1978), and Becker and Murphy (1993).

characteristics of the products.[2] Common knowledge of prices also abstracts from the Bagwell and Ramey (1994a) and (1994b) models of advertising to coordinate on the low price firm. A priori the only missing information for the consumer is the identity of the brand that will turn out to be the more widely purchased.

Since our consumers have common knowledge of the qualities of the products, advertising is not informative through signaling. And the empirical implications of the coordinating role of advertising are quite different from the implications of signaling advertising as in Kihlstrom and Riordan (1984). When advertising is informative about the quality of the product through signaling, firms with higher quality experience goods have a higher level of advertising in equilibrium. This would imply a positive correlation between quality and advertising. However, in a cross-sectional analysis, Moorthy and Zhao (1995) do not find a significant positive relation between quality and advertising spending. Zhao (2000) shows that when advertising functions both as a signaling device and as a device to increase awareness of the consumers about the product, in equilibrium the firm with the high-quality product spends less on advertising than the firm with the low-quality product. In a market with consumption externalities, when advertising serves as a coordination device similar equilibrium predictions arise.

In markets with consumption externalities, the firm with the lower quality product will have a greater incentive to advertise in order to coordinate consumer expectations on its own brand. Hence, in equilibrium, the lower quality product will often be more popular. If however the quality difference between the products is drastic, advertising for coordinating purposes is

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[2]See Butters (1977), Grossman and Shapiro (1984), Meurer and Stahl (1994), Robert and Stahl (1993), Stahl (1994) and Stegeman (1991) for informative advertising. In Kihlstrom and Riordan (1984), Milgrom and Roberts (1986), Nelson (1974) and Bagwell and Ramey (1994a) advertising is informative through signaling.

not observed. Thus in a model with randomly matched firms with three possible qualities, mid-quality firms would be competing in advertising with low, medium and high quality firms while high and low quality firms would not engage in advertising competition. Hence the results of the model are consistent with the empirical work of Horstmann and Moorthy (2003) who show that in a sample New York City restaurants that mid-quality restaurants tend to advertise more than either high or low quality restaurants.[3]

II. THE FRAMEWORK

Consider a market with two brands and a unit continuum of consumers who differ in their taste (α) for the product, $\alpha \sim U[0, \bar{\alpha}]$. Consumers' preferences exhibit positive consumption externalities. The value the consumer gets from the product is not only a function of the quality of the product (V) but is also increasing in the number of the people (q) who purchased the same brand. While there are two brands available, consumers want at most one product from each brand. Thus, if this is the market for books, some consumers may prefer to buy more than one book, but no one will purchase the same book twice. The utility function exhibits diminishing marginal utility. Consumer i's indirect utility is given by:

$$U_i = \begin{cases} 0 & \text{if he makes no purchases} \\ (\alpha_i V_j + \beta q_j - P_j) & \text{if he buys only product j} \\ (\alpha_i V_j + \beta q_j - P_j) + (\omega \alpha_i V_k + \beta q_k - P_k) & \text{if he buys product j and then k} \end{cases}$$

for $j,k \in \{A,B\}$ and $j \neq k$, $\beta > 0$, $\omega \in (0,1)$. P is the price, β is the consumption externality parameter and ω yields diminishing marginal utility.

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[3]Restaurant meals are often modeled as goods with positive consumption externalites as it may be more pleasant to eat with company or desirable to be seen at a fashionable venue, see for example Becker (1991).

For example, this specification of consumers seems to be a reasonable approximation of the market for movies. Since in addition to watching movies, many people like to talk to each other about movies, this market is often used as an example of a market with consumption externalities. In practice it seems that consumer coordination is crucial to a movie's success. The movie's success (in terms of total ticket sales) in the first weekend after it is released is widely seen in the industry as the key to a profitable film.[4] If a product with positive consumption externalities has high early sales, later consumers will have more incentive to purchase that good and this snowball effect will result in high total sales. This feature of markets with consumption externalities affirms the belief in the movie industry that a firm's ability to coordinate consumer expectations on its product during the opening weekend will be crucial to its success. In this paper we will model purely coordinating advertising, with no word-of-mouth communication about the popularity of the good: Our consumers will make their purchasing decisions simultaneously, after firms advertise, but before observing the actions of other consumers. Thus in the movie industry interpretation it is advertising aimed at creating high first-weekend sales that will be examined.[5]

At the retail level, a movie theater will typically carry the products of more than one studio and sell tickets to moviegoers at the same price. That is, at a particular theater the tickets to a popular movie will typically sell for the same price as the tickets to an unpopular one. We will not attempt to explain this phenomenon but take it as given. This feature of the market

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[4]For example, see "The Won and Lost Weekend," The Economist, November 29, 1997, pg. 87.

[5]Studios spend up to three quarters of a movie's promotion budget in the 4-5 days before it opens, ibid. pg. 87.

permits us to focus on the role of advertising unencumbered by the interactions between advertising and retail price competition.[6]

Two producer firms (A, B) provide service to an additional consumer at zero marginal cost. The products of the firms are of potentially different qualities, V_A and V_B. Without loss of generality we will assume throughout that $V_A \geq V_B$. Both A and B's products sell at price P. The producer firm captures a percentage $\gamma \in (0,1]$ of the sales receipts from its product.[7]

In order to guarantee interior solutions to the consumers' problem we will make two assumptions on parameter values.[8] First, we will assume that for some of the consumers the product is desirable enough to purchase both goods, even in the absence of consumption externalities:

$$\bar{\alpha} > \frac{P}{\omega V_B} \tag{1}$$

Secondly, we assume that the consumption externality is relatively mild so that a consumer who does not care for the product ($\alpha=0$) will never purchase it just for the externality, even if everybody else is buying it,

$$\beta < P \tag{2}$$

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[6]Endogenizing the prices is not conceptually difficult. See, Pastine and Pastine (2002) for a dynamic model with homogeneous consumers where firms' advertising and price decisions are endogenously determined. In the model here endogenizing prices yields pricing incentives and equilibrium virtually identical to those examined in Karni and Levin (1994), without changing the fundamental incentives in the advertising decision that we are focusing on here. Nevertheless, avoiding these complications permits a much clearer understanding of coordinating advertising in markets with consumption externalities.

[7]The typical contract between a movie studio and the theaters ties the producer's revenue directly to ticket sales. This risk-sharing arrangement helps to ensure that the studios have incentives to promote their movies.

[8]The analysis of the possible corner solutions in the absence of these assumptions is simple but creates numerous sub-cases without adding any intuition or altering the basic conclusions.

Together assumptions (1) and (2) yield a market which is fundamentally driven by product value. Consumption externalities will be important in this market, but not to the extent that they eclipse the fundamental value of the product to consumers.

III. EQUAL QUALITIES

In this section we analyze the case where the products have equal quality, $V_A = V_B \equiv V$. First we will explore the possible equilibria in this case. Because of the existence of consumption externalities, there are multiple equilibria in this market: Consumers can coordinate on one of the products, or there might be no coordination.

3.1. Multiplicity of Equilibria

No coordination. The products A and B have the same quality and they have the same price. If firms do not engage in some activity to differentiate their products from each other, consumers do not have a device to coordinate their expectations about the popularity of the products. Hence, in equilibrium, consumers may expect that A and B will sell the same quantity $E(q_A) = E(q_B) = q$.

While some consumers may choose not to purchase neither of the products (consumers with low α) others will purchase one item. And the consumers who have a high taste for the product (with high α) will purchase both items. A consumer will purchase a second product if the additional utility from the second product is higher than the price, $\alpha \omega V + \beta q \geq P$. Hence all of the people with high enough taste, $\alpha \geq \alpha'' = \dfrac{P - \beta q}{\omega V}$ will buy A and B. This implies that the proportion of people who buy both of the products is given by $\left(1 - \dfrac{P - \beta q}{\bar{\alpha} \omega V} \right)$ since $\alpha \sim U[0, \bar{\alpha}]$.

A consumer whose additional utility from the first purchase is less than the price, $\alpha V + \beta q \leq P,$ will not buy either of the products. So consumers with a low enough taste for the good, $\alpha < \alpha' = \dfrac{P - \beta q}{V}$, will not buy either of the products. Hence, the proportion of people that

purchase a single product is $\left(\dfrac{P-\beta q}{\overline{\alpha}\omega V} - \dfrac{P-\beta q}{\overline{\alpha}V} \right)$. People that decide to buy a single product are indifferent between A and B, so they split between the products. Hence the proportion of people that buy a particular product is given by the proportion of consumers that purchase both items plus half of the proportion of consumers that purchase on item:

$$q=1-\frac{(P-\beta q)(1+\omega)}{2\overline{\alpha}\omega V}$$

This yields the equilibrium number of people who purchase each good.

$$q= 1 - \frac{(P-\beta q)(1+\omega)}{2\overline{\alpha}\,\omega V} \qquad (3)$$

Solving for q, we get:

$$\frac{2\overline{\alpha}\omega V - P(1+\omega)}{2\overline{\alpha}\omega V - \beta(1+\omega)} \equiv \tilde{q} \qquad (4)$$

Notice that $\tilde{q}<1,$ since P>β. And $\tilde{q}>0$ since $\overline{\alpha} > \dfrac{P}{\omega V}$. As the price goes up, quantity demanded goes down. An increase in the consumption externality parameter β leads to an increase in the quantity demanded.

Coordinated Demand Equilibria. Suppose that consumers believe that firm j will sell more than firm k, $E(q_j)>E(q_k)$ $\forall j,k \in\{A,B\}$ where j≠k. All else equal consumers would prefer j's product, since they expect it to realize the consumption externalities.

Since the expected qualities of the products are the same, the only people that will purchase k will be the ones that will buy both j and k. A consumer will purchase k if the additional utility from k is higher than the price, $\alpha\omega V+\beta q_k \geq P$. So everyone with a high enough

taste for good, $\alpha \ge \alpha'' = \dfrac{P - \beta q_k}{\omega V}$, will purchase A and B. The proportion of people who buy k is given by $q_k = \left(1 - \dfrac{P - \beta q_k}{\bar{\alpha} \omega V}\right)$. Solving for q_k yields:

$$q_k = \frac{\bar{\alpha} \omega V - P}{\bar{\alpha} \omega V - \beta} \equiv \underline{q} \tag{5}$$

All of the people whose marginal utility from the first purchase is higher than price, $\alpha V + \beta q_j \ge P$ will buy j. So people with $\alpha \ge \alpha' = \dfrac{P - \beta q_j}{V}$ will purchase j. The proportion of the people who purchase j is $\left(1 - \dfrac{P - \beta q_j}{\bar{\alpha} V}\right)$. Solving for q_j yields:

$$q_j = \frac{\bar{\alpha} V - P}{\bar{\alpha} V - \beta} \equiv \bar{q} \tag{6}$$

Inspection of (5) and (6) reveals that $\bar{q} > \underline{q}$ since $P > \beta$ and $\omega < 1$. Also notice that the proportion of people that buy j in the coordinated demand equilibrium is greater than the proportion of people that buy j when there is no coordination, $\bar{q} > \tilde{q}$. On the other hand, the proportion of people that buy k declines when consumers coordinate on j compared to the case where there is no coordination, $\underline{q} < \tilde{q}$.

3.2. The Role of Advertising

The existence of consumption externalities leads to multiplicity of equilibria. There is an equilibrium where consumers coordinate on A. There is also an equilibrium where consumers coordinate on B. If the companies do not do anything to differentiate themselves from each other, there also is a symmetric equilibrium where equal numbers of consumers purchase each product. Firms have preferences over these possible equilibria. Thus, firms may try to differentiate themselves via advertising to coordinate consumer expectations on their own brand.

In light of the multiplicity of equilibria, imagine a consumer who observes an advertising campaign. The consumer must suppose either that the advertising was a mistake, or that advertising will lead to increased sales. And in fact there are several equilibria so either set of expectations is perfectly rational. But they are not equally plausibly as general predictions of consumer behavior. If a firm invested in advertising it must have believed that advertising would result in increased sales, and consumers are likely to take this into account when forming their own expectations. Notice using advertising in coordinating expectations is not just a sunspot argument. For consumers to ignore advertising in forming their expectations they must treat observed advertising as costly mistakes by irrational firms.

3.3. The Nature of Advertising Competition

When consumers coordinate on A, $q_A > q_B$ and when consumers coordinate on B, $q_B > q_A$. Firms have strict preferences over these equilibria. This implies that it is worthwhile for the firms to exert effort in a competition over the coordination of consumers. Let us momentarily postulate that the firm that advertises more heavily can coordinate consumers on its own brand, and find the equilibrium in the advertising competition. Using this we will then argue that this is likely to be the equilibrium outcome: It is indeed rational for the consumer to prefer to purchase the more heavily advertised product.

Abstracting from all other functions of advertising, when the only role of advertising is to coordinate consumer expectations, advertising competition has the same form as the first-price all-pay auction. In a first-price all-pay auction all participants must pay their bids regardless of whether they win the auction or not, and the highest bidder receives the prize. Hence all-pay auctions have been used to model lobbying for monopoly rents, R&D races, political campaigns, tournaments and job promotion. In our framework, the more heavily advertised brand (the firm

with the highest bid in the form of advertising expense) can coordinate consumers. To apply the results of the auction literature to our coordinating advertising competition, we need to determine the value of the auction to the firms (the value of winning the advertising competition). The value of the auction for a firm is the difference in the profits the firm would get if consumers coordinate on its product versus if consumers coordinate on the rival's product. If both firms end up with the same level of advertising, each of their sales is given by (4). If a firm out advertises its rival its sales are given by (6) and if its competitor out advertises it, its sales are given by (5). Therefore the value of "winning" the auction to each firm (Γ) over and above the value of losing is given by the difference between these quantities , $\overline{q}$ and $\underline{q}$, times the price of the product, times the share of sales which go to the producer,

$$\Gamma = \frac{\gamma P(P - \beta)\overline{\alpha}V(1 - \omega)}{(\overline{\alpha}V - \beta)(\overline{\alpha}\omega V - \beta)} \tag{7}$$

Since the firms' problems are symmetric, the value of winning the advertising competition is the same for both producers.

Notice that in this advertising competition pure-strategy Nash equilibria do not exist. If one firm has the pure strategy of not advertising, then the other will advertise a small amount, capturing the coordinated demand, and the first would rather have out advertised that small amount. Likewise, if a firm has a pure strategy with a positive level of advertising, its rival will either prefer not to advertise at all or to out advertise the firm. If the rival chooses not to advertise, then the firm would have preferred to out advertise with a very low level of advertising. If the rival chooses to out advertise the firm, then the firm would have preferred not to have advertised at all. Thus, there can be no pure-strategy Nash equilibrium.

Claim 1: *When firms are symmetric, the advertising competition results in the expected dissipation of all gains to advertising.*

Proof: With two firms there is a unique symmetric mixed-strategy equilibrium in this advertising competition. No firm will engage in a strictly positive advertising expense with positive probability. If a firm were to advertise a positive amount "a" with positive probability, then there would be an interval [a-ϵ, a] on which the rival would strictly prefer not to advertise. Hence the firm can slightly decrease its advertising expense below "a", and still be able to coordinate consumers on its own brand with the same probability, contrasting the assumption that the initial situation was an equilibrium. Hence this equilibrium involves continuous mixed strategies, apart possibly from the advertising expense of zero which may occur with a positive probability[9].

Notice that no firm would ever spend more on advertising than the value of winning the competition, Γ. But if a firm's rival was going to spend less than Γ, it would be in the firm's best interest to out advertise it. So in equilibrium both firms mix in the range [0,Γ]. Since Γ is in the support of the strategy, in expectation all returns to advertising are dissipated and in equilibrium firms spend an expected value of $\Gamma/2$ each.[10] Since firms have identical values of winning the auction, in expectation they each dissipate half of their possible winnings (Γ) in advertising expenses. Hence the advertising competition results in the expected dissipation of all gains to advertising. □

Each wins only half of the time, so ex-ante each is indifferent between advertising and simply allowing the other to capture the coordinated demand. That is, while the actual profits of each firm depend on the outcome of the mixed-strategy equilibrium in advertising competition,

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[9]See Ellingsen(1991) for the derivation of equilibria in all-pay auctions.

[10]The literature on all-pay auctions is extensive. For uniqueness of this mixed-strategy equilibrium see Ellingsen (1991). With more than two players there may not be a unique equilibrium, but this result on the costs for the two players with the highest valuation can be obtained across all equilibria, see Baye, Kovenock and De Vries (1993).

the expected profits are simply the profits that the firm would get if it simply passively allowed its rival to coordinate consumer expectations on its product.[11] In this case, the firm's sales would be given by $\underline{q}$ which is strictly less than the sales the firm would get if neither firm advertised, $\tilde{q}$. Thus both firms would be better off if they could agree not to advertise. However, each would have an incentive to cheat on such an agreement because if their rival was not going to advertise, then the firm could coordinate consumer expectations on its product with minimal advertising expenses and capture sales of $\overline{q}$ which are strictly higher than the sales it could get if it abided by the agreement.

Due to advertising, more people buy at least one product (a business creation effect). When firms do not advertise, the products are identical in every aspect and consumers cannot coordinate their expectations. Without coordination, only people with $\alpha \geq \dfrac{P - \beta\tilde{q}}{V}$ purchase the good. But when consumers coordinate their expectations on a brand, the positive consumption externality creates an additional incentive for the consumers to buy that brand. In the movie interpretation this means that even people who do not enjoy movies in general go to the movies, since they expect to socialize with more people, so all the people with $\alpha \geq \dfrac{P - \beta\overline{q}}{V}$ go to the movies, where $\dfrac{P - \beta\overline{q}}{V} < \dfrac{P - \beta\tilde{q}}{V}$ since $\overline{q} > \tilde{q}$.

Due to advertising, fewer people buy the less advertised product (a business stealing effect). Advertising causes the demand for the less advertised brand to decline. Without advertising consumers who were going to purchase one item would split between the products. With advertising the firm with lower advertising no longer gets these customers. It only gets consumers who value the good enough to purchase both. Hence, the incentive to purchase the second item has declined. Inspecting (4) and (5), $\underline{q} < \tilde{q}$.

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[11]The random nature of the outcome is consistent with the uncertainty reported by market participants engage in advertising competition. See for example the insider account by Enrico and Kornbluth (1986).

Due to advertising, total quantity sold goes down (a business dissipation effect). Total sales when there is no advertising is the summation of the demand for A and demand for B, given by $2\tilde{q}$. When one firm advertises more than the other, one gets $\bar{q}$ and the other gets $\underline{q}$. There is a reduction in the total sales,

$$\underline{q} + \bar{q} - 2\tilde{q} = - \frac{(P - \beta)(1 - \omega)^2 \beta \bar{\alpha} V}{(\bar{\alpha} V - \beta)(\bar{\alpha}\omega V - \beta)(2\bar{\alpha}\omega V - \beta(1 + \omega))} < 0 \qquad (9)$$

With coordination, one firm has high demand and the other has low demand. Hence the incentive for a consumer to buy his first product increases, and the incentive to buy his second decreases. But since the consumer has diminishing marginal utility from the consumption of the product, the intrinsic value of the second purchase is less important relative to the consumption externality than it is for the first purchase. Hence coordination increases the sales of highly advertised product less than it decreases the sales for the less advertised product.

Claim 2: *It is rational for a consumer who is only purchasing one product to buy the more heavily advertised one.*

Proof: The prices and the expected qualities of the two products are the same and suppose that A is more heavily advertised than B. Due to the stochastic nature of the advertising competition ex-post the firm who losses the advertising competition will have regrets. But the consumer will realize that firms advertised only because they expected advertising to increase their sales. So the individual consumer will realize that firms believe that advertising is being used as a coordination device, and that firms are confident enough about this belief to invest large sums of money. Hence it will in fact be in the best interest of a rational consumer to choose to buy the more heavily advertised brand. In aggregate, this leads to higher sales, higher consumption

externalities and hence greater consumer surplus from the more heavily advertised product.

□

IV. VERTICAL DIFFERENTIATION

In section III, we have described the equilibria with and without coordination, when the qualities of the products A and B were the same. In markets with vertical differentiation consumers can learn about the qualities of the products based on trusted critics. For instance, in the movie industry the famous critics Siskel & Ebert used to give an indication of the quality of the movies.[12] Computer magazines rate the qualities to software packages. There is consumer reports on reliability of different brand name automobiles. So let us imagine that consumers know the qualities of the products and $V_A > V_B$. We will examine whether multiple equilibria exist when one product is of superior quality. When A has a higher quality, is it ever rational for consumers to coordinate on the low quality product? We then discuss which one of these equilibria is more likely under which circumstances.

Coordinate on A. Suppose that consumers believe that more people will purchase A, $E(q_A) > E(q_B)$. If a consumer buys only one item, he will prefer A, for two reasons. First, he expects to enjoy A more due to higher quality. Secondly, he expects to find more people around to talk about A. The only people that end up buying B are the ones who purchase both of the

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[12]They may also form their expectations based on other information, such as the director or lead actor. For an interesting analysis of firm response to product reviews see Chen and Xie (2005). Here we will continue to abstract from the signaling role of advertising by assuming that consumers have common knowledge of product quality.

products. Buying the second item yields the additional utility $\alpha\omega V_B+\beta q_B-P$. Therefore, all of the consumers with $\alpha \geq \dfrac{P-\beta q_B}{\omega V_B}$ will buy B. Solving for the equilibrium q_B, we get:

$$q_B \;=\; \frac{\overline{\alpha}\omega V_B - P}{\overline{\alpha}\omega V_B - \beta} \tag{10}$$

Since $P>\beta$, $0<q_B<1$.

Everyone with a positive consumer surplus from A, such that $\alpha V_A + \beta q_A \geq P$, will buy A. Solving for the equilibrium q_A, we get:

$$q_A \;=\; \frac{\overline{\alpha} V_A - P}{\overline{\alpha} V_A - \beta} \tag{11}$$

since $V_A > V_B$, sales of A are greater than the sales of B, $q_A>q_B$.

Coordinate on B. When A is the higher quality product, can it be rational for consumers to believe that B will receive more customers than A, $E(q_A)<E(q_B)$? Below we will show that $E(q_A)<E(q_B)$ is only rational when A and B are of similar qualities. If the quality difference between the two products is too large, then the expectation that $q_B>q_A$ is not rational, and hence there is no multiplicity of equilibria. It is only when the products are of similar qualities that advertising may have a coordinating role to play in this market.

If A is the higher quality product and consumers believe that B will receive more customers, $E(q_A)<E(q_B)$, then the product that consumer i prefers to buy depends on that consumer's taste for the good. For high α_i such that $\alpha_i V_A+\beta q_A>\alpha_i V_B+\beta q_B$ the consumer would find the high quality of product A more attractive. This consumer would buy A if he was only

going to buy one item. Define $\tilde{\alpha}$ as the level of α where a consumer is indifferent between A and B if he is only buying one item:

$$\tilde{\alpha} = \frac{\beta(q_B - q_A)}{V_A - V_B} \qquad (12)$$

Consumers with $\alpha \geq \tilde{\alpha}$ prefer A over B, due to its high quality, and consumers with $\alpha < \tilde{\alpha}$ prefer B over A, due to the consumption externality. As before, if α_i is low ($\alpha_i < \alpha'$), the consumer i will not buy either of the products. If α_i is high ($\alpha_i > \alpha''$), he buys both of the products. However, if α_i takes an intermediate value, he will buy one, and the one he chooses will depend on the relationship between α_i and $\tilde{\alpha}$. There are three potential cases $\tilde{\alpha} \leq \alpha'$, $\alpha' < \tilde{\alpha} \leq \alpha''$, and $\tilde{\alpha} > \alpha''$. We will show that the only possibility for rational expectations of $q_B > q_A$ is in the third case where the parameter values are such that $\tilde{\alpha} > \alpha''$.

The first case ($\tilde{\alpha} \leq \alpha'$) directly implies than $q_B < q_A$ and so the consumers' expectations that $q_B > q_A$ are not rational. The second case ($\alpha' < \tilde{\alpha} \leq \alpha''$) is less obvious, but is also not possible in equilibrium. To see this notice that in this case everyone with $\alpha_i \geq \tilde{\alpha}$ will buy A so, $q_A = 1 - \dfrac{\beta(q_B - q_A)}{\bar{\alpha}(V_A - V_B)}$. Solving for the quantity firm A sells, $q_A = \dfrac{\bar{\alpha}(V_A - V_B) - \beta q_B}{\bar{\alpha}(V_A - V_B) - \beta}$. Notice that this yields $q_A \geq 1$, so the expectation of $q_B > q_A$ is not rational. If the parameters are such that $\tilde{\alpha} \leq \alpha''$ consumer expectations of $q_B > q_A$ are not rational.

Thus the only possibility for rational expectations of $q_B > q_A$ is if $\tilde{\alpha} > \alpha''$. As before, α'' is where the consumer's additional utility from buying two items instead of one is just equal to the price of the product. If the consumer buys one item only, he will buy B. The utility from purchasing one item is therefore $\alpha_i V_B + \beta q_B - P$. The utility from two items is equal to

$[\alpha_i V_A + \beta q_A - P + \alpha_i \omega V_B + \beta q_B - P]$. Hence the additional utility from buying the second item

is equal to $[\alpha_i V_A - \alpha_i(1-w)V_B + \beta q_A - P]$. Finding the α where this is zero,

$$\alpha'' = \frac{P - \beta q_A}{V_A - (1-\omega)V_B} \tag{14}$$

The only consumers who buy A are those who value the good so much that they buy both A and

$B(\alpha_i > \alpha'')$. Therefore q_A is given by,

$$q_A = 1 - \frac{P - \beta q_A}{\bar{\alpha}V_A - \bar{\alpha}(1-\omega)V_B} \tag{15}$$

solving for q_A,

$$q_A = \frac{[\bar{\alpha}V_A - \bar{\alpha}(1-\omega)V_B] - P}{[\bar{\alpha}V_A - \bar{\alpha}(1-\omega)V_B] - \beta} \tag{16}$$

Note $q_A \in (0,1)$ since $P > \beta$, $\bar{\alpha}\omega V_A > P$.

Consumers whose utility from purchasing B is positive, $\alpha V_B + \beta q_B - P > 0$ will buy B. This

yields the critical α',

$$\alpha' = \frac{P - \beta q_B}{V_B} \tag{17}$$

All consumers with $\alpha > \alpha'$ purchase B, therefore q_B is given by,

$$q_B = 1 - \frac{P - \beta q_B}{\bar{\alpha}V_B} \tag{18}$$

solving for q_B,

$$q_B = \frac{\bar{\alpha}V_B - P}{\bar{\alpha}V_B - \beta} \tag{19}$$

Note $q_B \in (0,1)$ since $P > \beta$, and $\bar{\alpha}\omega V_B > P$. Thus,

$$q_B - q_A = \frac{\bar{\alpha}(P - \beta)[(1-\omega)V_B - (V_A - V_B)]}{(\bar{\alpha}V_B - \beta)[\bar{\alpha}(V_A - V_B) + \bar{\alpha}\omega V_B - \beta]} \tag{20}$$

Notice that $q_B > q_A$ if $(1-\omega)V_B > (V_A - V_B)$.

These results also require that $\alpha'' < \tilde{\alpha}$ which imposes the condition,

$$\frac{P - \beta q_A}{V_A - (1 - \omega)V_B} < \frac{\beta (q_B - q_A)}{(V_A - V_B)} \tag{21}$$

Substituting in q_A from (16) and (q_B-q_A) from (20) and rearranging (21) yields,

$$(V_A - V_B) < \frac{(1 - \omega)\beta}{\overline{\alpha}} \tag{22}$$

(22) is the necessary and sufficient condition for the existence of an equilibrium where consumers coordinate on the low quality good. That is, if the quality difference between the two products is too large, then the expectation that $q_B > q_A$ is not rational, and advertising will not have a coordinating role to play in this market.

Claim 3: *If quality differences between the products are too large we will not observe advertising for coordination purposes.*

Proof: If the qualities of the two goods are very different – loosely speaking, one movie receives two thumbs up, the other two thumbs down, formally $\left[V_A - V_B \geq \frac{(1 - \omega)\beta}{\overline{\alpha}} \right]$ – there is only one equilibrium and it involves consumers coordinating on the higher quality good. In this case, everyone who buys a product purchases the higher quality one, and only those people who really like the product will purchase the lower quality one as well. Suppose B is a very low quality brand but that firm B did advertise. Because B is so poor, there is no rational expectations equilibrium where consumers coordinate on B. In this situation, purchasing the higher quality product is the only reasonable behavior, and consumers will coordinate on the higher quality product, even if faced with advertising for the low quality product. Hence rational firms will choose not to advertise when the quality difference between the products is too large. $\square$

When there are significant quality differences, there is no multiplicity of equilibria and firms cannot coordinate consumer expectations using advertising. Hence the quality assessments, such as movie reviews, are serving an informative role, but also, implicitly, they are serving a coordinating function as well. From (22), also notice that the larger the consumption externality (β) the more likely it is for advertising to possibly serve the coordinating role. If the consumption externality is small, the quality of the products becomes relatively more important in the purchasing decisions of the consumers. And the coordinating function is served by quality differences. If the taste for quality is high, $\overline{\alpha}$, it becomes less likely that (22) holds. So, if the importance of quality versus externality is high, advertising will not coordinate consumer expectations.

When the quality difference between the products is not too drastic, that is for parameter values where (22) holds, coordination via product quality may be difficult to achieve. Of course, if all else is equal it is quite natural for consumers to coordinate on the higher quality good. However, the producer of the lower quality good has strong incentives to ensure that all else is not equal. The fundamental problem is that there are two equilibria, and each individual consumer must try to predict which equilibrium the other consumers are going to play.

There is a subgame-perfect Nash equilibrium where consumers coordinate on the high quality brand and ignore all advertising. In this equilibrium firms would not advertise. Notice that for this equilibrium to survive, the off-equilibrium beliefs of the consumer must be such that the consumer interprets any positive level of advertising as irrational behavior of the firm. Now suppose that the producer of the lower quality product did actually mount a costly advertising campaign. An individual consumer could suppose that the firm engaged in the advertising campaign because it had information that consumers in general were going to use advertising to coordinate their expectations on one of the equilibria. In this case, a consumer who was only

going to buy one product would go to B, firm B's sales would increase, vindicating its investment in advertising.

Therefore, when the quality of the products are not too dissimilar, consumers may end up not coordinating based on product quality information. When Siskel & Ebert give one movie two thumbs up, and its competitor mixed reviews, this information on product quality may be not the deciding factor in coordinating consumer expectations. However, it will have a very significant effect on the incentives that the two firms face in their advertising competition.

Claim 4: *The value of winning the advertising competition is higher for the firm with the low quality product.*

Proof: The value of winning the advertising competition for a firm is proportional to the difference in sales when it coordinates consumers on its brand versus when the rival gets the coordinated demand. So for A the value of winning the advertising competition is proportional to the difference between (11) and (16):

$$\Gamma_A = \frac{\gamma P \, \bar{\alpha}(P - \beta)(1 - \omega)V_B}{(\bar{\alpha}V_A - \beta)[(\bar{\alpha}\omega V_B - \beta) + \bar{\alpha}(V_A - V_B)]} \qquad (23)$$

For B, the value of winning the advertising competition is proportional to the difference between (19) and (10):

$$\Gamma_B = \frac{\gamma P \, \bar{\alpha}(P - \beta)(1 - \omega)V_B}{(\bar{\alpha}V_B - \beta)(\bar{\alpha}\omega V_B - \beta)} \qquad (24)$$

The denominator of (24) is small since $V_A > V_B$. Hence the value of winning the advertising competition for firm B is higher. $\square$

Since B is the lower quality product, if A coordinates demand B only gets the small proportion of the consumers who have a very high taste for the good. Moving from this low demand to the coordinated demand implies big changes in sales for B. A is the higher quality product. Even when it does not coordinate consumers on its brand it still gets relatively high sales due to its high quality. Hence the value of winning the advertising competition is higher for the lower product firm.

Claim 5: *The expected profit created by entering the advertising competition for the low quality product is strictly positive and it is given by* $\Gamma_B - \Gamma_A > 0$.

Proof: This result has been proven by Ellingsen (1991, Proposition 1) for all-pay auctions when participants have asymmetric valuations.[13] The same arguments as in the symmetric valuations case show that there exists no pure-strategy equilibrium and that the equilibrium must involve continuous mixed strategies. Firm A would never bid higher than the value of the auction Γ_A. Firm B can always win the competition by bidding slightly higher than Γ_A and collect the prize. This leaves B with an advantage in the advertising competition equal to the difference in valuations, so in equilibrium it is able to capture an expected profit from the advertising competition equal to $\Gamma_B - \Gamma_A > 0$. $\qquad\qquad\square$

While the firm with the low quality product strictly prefers engaging in advertising competition, the expected profit created by entering the advertising competition for the firm with the high quality product is equal to zero. Since an advertising expense Γ_A is in the equilibrium support for firm A, and since the value of winning the advertising competition is just equal to Γ_A,

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[13]Also see Baye, Kovenock and De Vries (1993) for a general statement on expected profits from the all-pay auction.

the expected profit created by entering the advertising competition for A is zero. Hence the firm with the high quality product is indifferent between entering the competition or not. However it would not be an equilibrium strategy for A not to enter the competition: Any announcement suggesting that A will not advertise would not be credible. If A were not to advertise, B would capture the coordinated demand with a small advertising expense. Then it would no longer be optimal for A not to advertise. It would rather out-advertise B with negligible advertising expenses. Hence in equilibrium both firms will advertise. Since there cannot be a pure-strategy equilibrium in an all-pay auction, the outcome of the advertising competition will be stochastic. Sometimes we will observe the producer of the high quality product advertising more, and other times we will observe the producer of the low quality product advertising more.

Claim 6: *The firm with the low quality product is more likely to win the advertising competition. As long as quality difference is not too drastic, consumers will more often coordinate on the low quality product.*

Define $G_A(a)$ as the probability of firm A having an advertising level less than or equal to 'a'. And $G_B(a)$ represents firm B's cumulative probability distribution. The expected value of the advertising competition to firm A is zero by the above argument. So when firm A advertises 'a', the expected value created due to advertising competition for firm A is given by:

$$0 = G_B(a) \ (\Gamma_A - a) + \big(1 - G_B(a)\big) \ (- a) \tag{25}$$

Solving for $G_B(a)$ yields:

$$G_B(a) \ = \ \frac{a}{\Gamma_A} \tag{26}$$

The expected value of the advertising competition to firm B is given by $\Gamma_B - \Gamma_A$ by result 6. When firm B advertises 'a', the expected value created due to advertising competition for firm B is given by:

$$\Gamma_B - \Gamma_A = G_A(a)(\Gamma_B - a) + (1 - G_A(a))(-a) \qquad (27)$$

Solving for $G_A(a)$ yields:

$$G_A(a) = \frac{\Gamma_B - \Gamma_A + a}{\Gamma_B} \qquad (28)$$

Now we are ready to find the probability of firm A winning the advertising competition. It is given by the probability that A advertises 'a' times the probability that B advertises less than 'a', integrated over the support of the mixed strategy:

$$\int_0^{\Gamma_A} G_B(x) \frac{\partial G_A(x)}{\partial x} dx = \frac{\Gamma_A}{2\Gamma_B} \qquad (29)$$

Similarly, the probability of coordinating on B is given by:

$$\int_0^{\Gamma_A} G_A(x) \frac{\partial G_B(x)}{\partial x} dx = \frac{2\Gamma_B - \Gamma_A}{2\Gamma_B} \qquad (30)$$

Since $\Gamma_B > \Gamma_A$, the probability that consumers coordinate on the low quality product is higher than the probability that consumers coordinate on the high quality product.

V. Empirical Implications

The coordinating role for advertising suggests that firms selling goods with consumption externalities have an additional incentive to advertise. Since effective coordinating advertising requires that consumers know that others have seen the advertising as well, advertisers of goods

with consumption externalities would prefer one publicly observable advertisement to many privately observable advertisements. Thus, *ceteris paribus*, these firms would be willing to pay more to reach a large audience with a single advertisement. Using a data set which includes advertising during the Super Bowl, Chwe (1998) is able to test this directly. He finds that it is the advertisers of goods which are likely to exhibit positive consumption externalities which do in fact choose to advertise on the most popular television shows, and are willing to pay a premium to do so.

In the model, we abstract from all the other roles of advertising. If advertising is being used solely as a coordinating device, the absolute level of advertising will have no effect on a firm's sales. What is important for coordination is the relative level of advertising compared to other firms. Even in a setting where advertising serves other roles, when it is also being used as a coordination device there will be a discontinuity in the response of consumers to advertising. The empirical work of Lambin (1976) and Porter (1976) is suggestive of such an effect. This hypothesis can be tested directly by regressing sales on the level of advertising expenditure and advertising expenditure relative to other firms. A significant coefficient on relative advertising would be in line with the prediction of the model. A significant coefficient on the level of advertising would indicate that advertising is also serving a persuasive or informative role.

Another implication of the model is that when quality differences are not too great, consumers will often knowingly purchase the lower quality product. This implies that consumers will watch many mediocre movies just for the consumption externality. Nevertheless, the movies that do the very best will be both of high quality and highly advertised. If quality differences are significant, the high quality product will always get the coordinated demand and in equilibrium we will not observe coordinating advertising. When Windows 95 and OS/2 were being introduced to the market, most of the software reviewers agreed that OS/2 was of slightly higher

quality than Windows 95. However Microsoft managed to coordinate consumer expectations on Windows 95. IBM complained about having lost market share to Microsoft despite their higher quality. This paper suggests that OS/2 would have not lost the battle if it was of significantly superior quality. The quality difference between these products must have been small enough that consumers chose to enjoy consumption externalities at the cost of a slight decline in the product quality.

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