Aggregators, Search and the Economics of New Media Institutions

Lisa George
Hunter College and the Graduate Center, CUNY

Christiaan Hogendorn
Weslyan

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Abstract

Media markets are typically understood as two-sided markets shaped by fixed production costs and marginal consumption costs linked to the quantity of advertising. But the proliferation of digital content makes search and other transaction costs a potentially important driver of consumer behavior. This paper studies the effect of search technology, aggregation and other institutions on heterogenous readers and advertisers in digital media markets. A simple model shows how these institutions can alter both market participation and the share of multi-homing readers, which in turn affects equilibrium prices and profits in the advertising market. When advertisers are horizontally differentiated, new media institutions alter the share of surplus to mass market and niche advertisers. The results offer both positive and normative predictions about the value of traditional and new media firms in a digital environment.

1 Introduction

Economics has in recent years made substantial progress in understanding the operation of media markets. The literature has progressed largely by examining the implications of media production technology, namely high fixed costs in supply, falling marginal costs of distribution, and public good features that limit the role of prices in efficient allocation. The dominant theoretical framework in the literature is discrete choice, which is the natural approach in an environment of few products. The three dominant strains of the literature all fit this mold. The literature on preference externalities explores how the distribution of tastes drives the production and consumption of variety under the varying fixed cost conditions of different media. The literature on media bias studies how the incentives of advertisers and politicians drive product position and coverage when products are few and funded by advertisers or other parties imperfectly aligned with the preferences of media consumers. The diverse literature on media effects documents the ways that media markets shaped by high fixed costs affect the behavior of voters, firms and politicians outside of media markets themselves. The unifying features of this work are the fixed costs and advertiser finance that limits supply and consumer choice.

But as this literature developed, technology altered the economic fundamentals of the industry in important ways. Integrated media markets on the internet dramatically increased the amount of news and information available to most consumers. At the same time, the costs of producing and distributing content of all sorts fell dramatically, with contributions from academics, public intellectuals, firms and political institutions competing with traditional media for consumer attention. This explosion in supply imposes potentially large costs on consumers seeking news or information on any topic. The result is a market driven less and less by fixed costs of supply and more and more by transaction costs in demand.

This paper studies the institutions that have emerged in the new environment of low production costs and high consumption costs in media market, namely search and "aggregation." We model improved search engines as reducing the transaction costs of locating content. We model aggregators, either in the form of traditional media platforms or internet sites that bundle free-standing content, as reducing the cost of visiting multiple sites. In a two-sided market, institutions that alter multi-homing affect equilibrium prices and profits in the advertising market. When advertisers are horizontally differentiated, new media institutions alter the share of surplus to market and niche advertisers. Our model thus generates both behavioral and welfare behavioral predictions for consumers, advertisers and content producers in a digital environment.

While our approach owes much to the two-sided approach to media markets developed by Anderson and Coate (2005) and Gabszewicz et al. (2006), our specification of both viewer and advertiser preferences is novel. Viewers in our framework derive utility from time spent reading content offered on atomistic web sites or "outlets." Viewers are characterized by how quickly the marginal utility of viewing diminishes as more time is spent on a given outlet. This type of viewer heterogeneity can give rise to switching behavior, with some viewers visiting more than one outlet and others spending all of their time on a single site. All viewers face a transaction cost associated with finding content, but "switchers" search more often and thus face higher transaction costs from search. Media institutions affect these transaction costs in different ways, generating both behavioral predictions and welfare estimates.

Advertisers in our model are horizontally differentiated, selling products that are more or less closely related to available content sites. In the fashion typical of models of horizontal differentiation, advertisements earn a fixed revenue less a transport cost, which we interpret as a cost of imperfect targeting. Advertisers close to the endpoints of a Hotelling line are those that sell "niche" products closely associated with outlet content, while those in the center of the line offer "mass market" products deriving less benefit from targeted content. Advertisers in our model can choose to place advertisements on both outlets, receiving a positive but discounted benefit from repeat impressions. More importantly, the value of repeat impressions is lessened due to reaching viewers on the "distant" site. The transport cost in our model thus also offers a natural way of thinking about advertising *context*, or circumstances where the same individual has a higher value to a particular advertiser on some sites than on others.[1] The importance of context-dependent advertising, which has received some treatment in psychology and marketing but not economics, is of interest independent of the institutions driving consumer behavior.

Following the literature, media outlets choose advertising prices to maximize advertising revenues, which depend on viewership. We do not, however, incorporate viewer disutility of advertising in our model as is the standard following Anderson and Coate (2005). [2] Hence outlet pricing decisions play no direct role in the number of viewers at each site. This simplified outlet model allows a clear focus on the effects of institutions on viewer behavior. We model improved search technology as reducing the transaction costs of locating content, which in the model induces both greater market participation and more switching. Internet aggregators or other platforms that bundle content allow viewers to visit multiple content sites for a single transaction cost, which tends to raise the benefits of switching relative to exclusive viewing. Because they lower transaction costs, the institutions generally increase welfare for viewers, advertisers and platforms. But institutions which reduce the costs of visiting multiple web sites also increase switching behavior, which alters the distribution of profits across advertiser types as well as platform profits.

To keep our analysis tractable, we make several important assumptions and simplifications. Content is produced exogenously at no cost, so our model does not speak to the role of new institutions on the supply of news and information. Throughout most of the paper we assume the presence of only two content sites, which aids in the tractability of our basic model. As noted above, we do not model the cost of advertising on viewers. In general, these assumptions can be relaxed, but doing so contributes little to the understanding of the institutions that are the primary focus of the paper.

The paper proceeds as follows. Section 2 places our model in the context

[1] We distinguish here between traditional notions of targeting, typically interpreted as heterogenous advertiser valuation for different consumer attributes (often demographics) and context, which we interpret as heterogenous advertiser valuation for different content attributes.

[2] Athey, Calvano and Gans (2010) also abstract from viewer disutility of advertising.

of the economic literature on media markets and advertising as well as the emerging literature on new media institutions, which is largely a literature on networks. Section 3 develops the basic model. Section 4 examines the role of aggregation and search on viewers, advertisers and media outlets. Section 5 discusses empirical applications and concludes the paper.

2 Literature

This paper contributes to several strains of the literature on media and advertising. Our basic model is closely related to the two-sided market analysis of media developed by Anderson and Coate (2005). Most work in this area centers on the negative externality imposed by advertising and the associated welfare implications under imperfect competition. Until recently, virtually all research in this area studied market outcomes with single-homing readers and multi-homing advertisers. Recent papers by Ambrus and Reisinger (2006), Athey, Calvano and Gans (2010) and Anderson, Foros and Kind (2010) develop richer models of viewer behavior that induce viewers to visit multiple sites. These models offer predictions more in line with stylized facts and create new avenues to connect the two sides of media markets. Viewer switching (often called multi-homing in the two-sided market literature) drives many of the results in our model, though the effect arises through transaction costs rather than the advertising externality.

The paper also contributes to a small literature on targeted advertising, both in media and non-media contexts. Early work in this area by Iyer, Soberman, and Villas-Boas (2005) consider targeted advertising to segmented consumers in an environment of imperfect competition. Following the advertising literature, Iyer et al. emphasize the effect of targeted advertising on equilibrium prices for advertised products. More recent research explicitly considers the role of targeted media in competition for advertisers, emphasizing equilibrium outcomes in the market for advertising. Athey, Calvano and Gans (2010) study how consumer tracking technology can effectively create advertising capacity. Bergemann and Bonatti (2010) emphasize the role of technology in improving matches between consumer preferences and advertised products. Goldfarb and Tucker (2010) find that better targeted advertising is worth more to advertisers and commands a higher price.

The paper is also related to an experimental literature in psychology that emphasizes the role of advertising context in advertisement value. Most of this work measures recollection of and attitude toward advertised products when ads are viewed in a laboratory setting. The bulk of this research considers affective contexts, for example whether advertisements are more effective in “happy” versus “sad” programming, or in an intellectual (news) versus “transportive” (suspense thriller) setting.[3]

The emphasis on broad mental and emotional states made sense in an era of broadcast television, where the sources of targeting and contextual variation available to profit-maximizing advertisers was limited. A newer literature, likely elicited in part by the proliferation of targeted cable television, studies advertising effectiveness in the context of different product environments. One study, for example, studied recollection of food advertisements on a cooking show relative to a car repair show, and a car advertisement on a cooking show relative to the car repair show (Furnham, Gunter and Richardson, 2002). Our model introduces an economic framework for studying context effects precisely of this sort.

3 Model

3.1 Viewers

There are a total of V viewers, each with an endowment of time T available for viewing content on an outlet. Each viewer i is characterized by parameter α_i uniformly distributed on [0,1], and each viewer's utility for spending time T_{ik} on outlet k is $U_{ik}(T_{ik})$. We assume that this utility function has

[3]For example, Furnham, Gunter, and Walsh (1998) find that advertisement recall was stronger in news rather than comedy environments. Goldberg and Gorn (1987) find ”mood congruence” of happy advertisements on happy programs and vice versa to improve recollection. These findings were supported by Kamins, Marks and Skinner (1991), who studied attitudes toward advertised products. Furnham, Gunter and Richardson (2002) offer a useful summary of the literature.

the following properties:

$$\frac{\partial U_{ik}}{\partial T_{ik}} > 0 \qquad \frac{\partial^2 U_{ik}}{\partial T_{ik}^2} < 0 \qquad \frac{\partial^3 U_{ik}}{\partial T_{ik}^2 \partial \alpha_i} < 0 \tag{1}$$

so that marginal utility of viewing time is decreasing as more time is spent on an outlet, and utility diminishes more quickly for viewers with higher values of α_i. Viewers also have an outside option to use their time T for other activities, and we normalize the utility of this outside option to zero. To fix ideas, it is helpful to consider $U_{ik}(T_{ik}) = \alpha_i T_{ik}^{1/2}$ which has these properties.

Searching for an outlet consumes t units of time. This has two effects: it reduces the time available for viewing content and it causes disutility of search effort ωt.

If there are two outlets available, each viewer i maximizes utility by one of three choices: not consuming content, spending all the time T on one outlet, or splitting the time equally between both outlets. Choosing one outlet incurs the search time t and its associated disutility once, while choosing both outlets incurs them twice. Each viewer thus solves

$$max\,\{0, U_{ik}(T-t) - \omega t, U_{i1}(T/2-t) - \omega t + U_{i2}(T/2-t) - \omega t\}$$

The viewer choice problem gives rise to two cutoff values of α: one where the viewer is indifferent between not viewing content and viewing one outlet, and another where the viewer is indifferent between viewing one outlet and viewing both. The cutoff for participation is

$$\begin{aligned} \alpha_i (T-t)^{1/2} - \omega t &\geq 0 \\ \alpha_i &\geq \frac{\omega t}{(T-t)^{1/2}} = \alpha_0 \end{aligned}$$

The cutoff between viewers who visit two outlets versus one is

$$\begin{aligned} 2\alpha_i (T/2-t)^{1/2} - 2\omega t &> \alpha_i (T-t)^{1/2} - \omega t \\ \alpha_i \left(2(T/2-t)^{1/2} - (T-t)^{1/2}\right) &> \omega t \\ \alpha_i &> \frac{\omega t}{2(T/2-t)^{1/2} - (T-t)^{1/2}} = \hat{\alpha} \end{aligned}$$

Consumers with higher α have more rapidly diminishing utility and will thus go to two outlets, consumers with lower α will choose to stay on one outlet. To ensure that there is always a positive number of these common viewers or "switchers," we make the following assumption:

Switchers Assumption: Search time is not too large relative to content viewing time so that some viewers always switch.

$$t < \frac{T}{3} \Rightarrow \hat{\alpha} > 0$$

We also need an to determine which particular outlet is chosen by the "exclusive" viewers who only visit one outlet. These viewers receive equal utility from spending all their time on either outlet, so we introduce a tie-breaker parameter β to determine which outlet they visit:

Tie-Breaking Assumption: Of the exclusive viewers, those with $\alpha < \hat{\alpha}$, fraction $\beta \in [0, 1]$ visit outlet 1 and fraction $(1 - \beta)$ visit outlet 2.

Using the tie-breaking assumption we can define

$v_1^e = \beta(\hat{\alpha} - \alpha_0)V$	number of exclusive viewers on outlet 1
$v_2^e = (1 - \beta)(\hat{\alpha} - \alpha_0)V$	number of exclusive viewers on outlet 2
$v^s = (1 - \hat{\alpha})V$	number of switchers

The total number of viewers of outlet k is $v_k = v_k^e + v^s$ and the total number of participating viewers of any type is

$$V_p = (1 - \alpha_0)V = v_1^e + v_2^e + v^s \tag{2}$$

Note that the number of views of outlets 1 and 2, $v_1 + v_2$, is greater than the number of participating viewers V_p because of the switchers. An important implication is that if the number of switchers increases without an increase in total participation, then the new switchers will come in shares β and $1 - \beta$ from the exclusive viewers of the outlets 1 and 2 respectively. This result will be important in our analysis, so we state it as the following lemma:

Lemma 1: Consider a change in the number of switchers that does not change overall participation. Then:

$$\left.\frac{\partial v_1^e}{\partial v^s}\right|_{V_p} = -\beta \qquad \left.\frac{\partial v_2^e}{\partial v^s}\right|_{V_p} = -(1-\beta) \tag{3}$$

3.2 Advertisers

There are A advertisers who seek to place advertisements in front of viewers. Advertisers are characterized by their position θ_j in a product space [0,1] where each endpoint is the location of one of the media outlets. Intuitively, advertisers "close" to an outlet sell products related to the coverage of that outlet, such as a cookware vendor at a recipe website or a lipstick maker at a beauty site. Advertisers equidistant from the endpoints find viewers at either site equally valuable. The Hotelling framework in this way represents a measure of targeting precision available to advertisers.

Advertisers can earn σ from the first advertisement impressed on a viewer less the Hotelling distance cost representing imperfect targeting. Let the price of an ad on outlet k be $p_k(\mathbf{v})$, where $\mathbf{v} = (v_1^e, v_2^e, v^s)$ is a vector describing the viewer outcome. Then the payoff to an advertiser of type θ_j which advertises only on outlet 1 is

$$R_1(\theta_j, \mathbf{v}) = (\sigma - \theta_j)v_1 - p_1(\mathbf{v}) \tag{4}$$

The payoff to an advertiser of type θ_j which advertises only on outlet 2 is

$$R_2(\theta_j, \mathbf{v}) = (\sigma - (1-\theta_j))v_2 - p_2(\mathbf{v}) \tag{5}$$

As we expect from this type of model, if $v_1 = v_2$ and all advertisers single-home, then those to the left of $\theta = 1/2$ advertise on outlet 1 and those to the right of $\theta = 1/2$ advertise on outlet 2.

If advertisers multi-home, their ads will make a second impression on the viewers who switch. Let the value of this second impression be $\gamma\sigma$, where $\gamma < 1$, less the relevant distance cost.[4] The payoff to multihoming

[4]Following Ambrus and Reisinger (2006), the baseline value of an impression σ can be viewed as the reduced form of a model where monopoly advertisers earn a fixed price S for each sale, which extracts all consumer surplus from buyers, who comprise a share

for an advertiser is

$$R_{12}(\theta_j, \mathbf{v}) = (\sigma - \theta_j)v_1^e + (\sigma - (1-\theta_j))v_2^e + (\sigma + \gamma\sigma - \theta_j - (1-\theta_j))v^s - p_1(\mathbf{v}) - p_2(\mathbf{v})$$

The first term in the above function is the payoff from reaching exclusive viewers on the "close" outlet. The second term is the additional payoff from reaching the exclusive viewers on the "far" outlet. The third term is the payoff from making both a first and second impression on the *switchers*. Some comments on this third term are warranted.

Empirical evidence from marketing suggests that $0 < \gamma < 1$, with repeated impressions worth less than initial impressions but greater than zero. More importantly, the payoff functions show that advertisers are making one of the impressions on switchers on the *far* outlet, where they are worth less because of the higher transport cost. The idea that the same individual might be worth less while visiting a second website is what we call the *context* of the advertisement. To illustrate, consider a woman who often purchases both cookware and lipstick. Both cookware vendors and lipstick vendors value impressions on this woman wherever she visits. But when the context for advertising matters, a cookware impression is more likely to convert to a cookware sale when the woman views the ad on a recipe website than when she views the ad on a beauty website.[5] We will return to this point when we discuss equilibrium prices and welfare.

Given these payoffs, the conditions for advertiser participation are

$$R_1 \geq 0 \qquad R_2 \geq 0 \tag{6}$$

and the conditions for multi-homing instead of single-homing are

$$R_{12} > R_1 \qquad R_{12} > R_2 \tag{7}$$

ρ of the viewer population. Viewers in the Ambrus and Reisinger model ignore ads with probability ϵ, which gives rise to the value of second impressions. With this approach, the baseline value of each impression in our model would be given by $\sigma = \rho S$ and the value of the repeat impression $\gamma\sigma = \gamma\rho S$. Unlike Ambrus and Reisinger, we do not allow the value of an impression to depend on viewing time, so individuals who divide viewing time between the two outlets convert to sales at the same rate as viewers who spend all their time on one site.

[5] Baker and George (2011) measure context effects in the market for local television.

By substituting the profit functions into these conditions, we can derive cutoff levels of θ between multi-homing and single-homing. Relative to single-homing on outlet 1, the cutoff level is

$$
\begin{gathered}
(\sigma - (1-\theta_j))v_2^e + (\gamma\sigma - (1-\theta_j))v^s > p_2(\mathbf{v}) \\
\sigma v_2^e + \gamma\sigma v^s - p_2(\mathbf{v}) > (1-\theta_j)(v_2^e + v^s) \\
(1-\theta_j) < \tfrac{\sigma v_2^e + \gamma\sigma v^s - p_2(\mathbf{v})}{v_2^e + v^s} \\
\theta_j > 1 - \tfrac{\sigma v_2^e + \gamma\sigma v^s - p_2(\mathbf{v})}{v_2^e + v^s} = \underline{\theta}
\end{gathered}
$$

Relative to single-homing on outlet 2, the cutoff level is

$$
\begin{gathered}
(\sigma - \theta_j)v_1^e + (\gamma\sigma - \theta_j)v^s > p_1(\mathbf{v}) \\
\sigma v_1^e + \gamma\sigma v^s - p_1(\mathbf{v}) > \theta_j(v_1^e + v^s) \\
\theta_j < \tfrac{\sigma v_1^e + \gamma\sigma v^s - p_1(\mathbf{v})}{v_1^e + v^s} = \overline{\theta}
\end{gathered}
$$

The cutoffs above are illustrated in Figure 1. Advertisers between the cutoffs advertise on both outlets, while those closer to the endpoints advertise on a single outlet only. This comports with intuition: advertisers with access to content "close" to their product would be expected to take advantage of these targeted sites while mass advertisers must reach consumers at multiple locations. A few observations are warranted. Higher prices on the "far" side shift the advertiser cutoffs inward, reducing the number of multi-homing advertisers. Larger numbers of switching viewers has the same effect. Higher advertiser payoffs for single or repeat impressions shift the cutoffs outward, increasing multi-homing.

Fig. 1: Advertiser Homing Behavior

3.3 Outlets

Each outlet k sets advertising price p_k. Advertising space is available at no cost to the outlet. In our model, advertisements do not affect viewer utility, so viewers choose outlets solely based on their utility of reading time, which neither outlets nor advertisers can influence.

Demand for advertising on outlet 1 is

$$A\overline{\theta} = A\frac{\sigma v_1^e + \gamma\sigma v^s - p_1(\mathbf{v})}{v_1^e + v^s} \tag{8}$$

while demand on outlet 2 is

$$A(1-\underline{\theta}) = A\frac{\sigma v_2^e + \gamma\sigma v^s - p_2(\mathbf{v})}{v_2^e + v^s} \tag{9}$$

Notice that outlets' demand functions do not depend on their competitor's price. This is a consequence of advertiser multi-homing, so that the competitor's price only affects the mix of single-homing versus multi-homing advertisers, but not the total number of advertisers on outlet k.

3.4 Equilibrium

The outlets choose price p_1 and p_2 to maximize

$$\Pi_1 = A\overline{\theta}p_1(\mathbf{v}) \tag{10}$$

and

$$\Pi_2 = A(1-\underline{\theta})p_2(\mathbf{v}) \tag{11}$$

Since $\overline{\theta}$ depends only on p_1 and $\underline{\theta}$ depends only on p_2, the outlets set prices as monopolists. The first order conditions are:

$$\frac{d\Pi_1}{dp_1} = A\overline{\theta} + Ap_1(\mathbf{v})\frac{d\overline{\theta}}{dp_1} = 0 \tag{12}$$

$$\frac{d\Pi_2}{dp_2} = A(1-\underline{\theta})p_2(\mathbf{v}) - Ap_2\frac{d\underline{\theta}}{dp_2} = 0 \tag{13}$$

Solving gives:

$$p_1^*(\mathbf{v}) = \frac{\sigma v_1^e + \gamma\sigma v^s}{2} \tag{14}$$

$$p_2^*(\mathbf{v}) = \frac{\sigma v_2^e + \gamma\sigma v^s}{2} \tag{15}$$

Prices depend on the number of exclusive and switching viewers, where the value of switchers depends on γ, the value of second impressions. Note that if second impressions are worthless, then prices are determined only by exclusive viewers. This is the incremental pricing result discussed by Anderson, Foros and Kind (2010).

With these prices, the advertiser cutoffs that determine advertising demand are:

$$\underline{\theta}^* = \frac{(1-\sigma)v_2^e + (1-\gamma\sigma)v^s}{2(v_2^e + v^s)} \tag{16}$$

and

$$\overline{\theta}^* = \frac{\sigma v_1^e + \gamma\sigma v^s}{2(v_1^e + v^s)} \tag{17}$$

Depending on the parameters, four different equilibrium outcomes are possible for advertisers. They are:

Case 1: All advertisers multi home.

$$\overline{\theta}^* \geq 1 \qquad \underline{\theta}^* \leq 0$$

Case 2: Some advertisers single home, others multi home.

$$\frac{1}{2} \leq \overline{\theta}^* < 1 \qquad 0 < \underline{\theta}^* \leq \frac{1}{2}$$

Case 3: Some advertisers single home, others do not advertise.

$$0 \leq \overline{\theta}^* \leq \frac{1}{2} \qquad \frac{1}{2} \leq \underline{\theta}^* \leq 1$$

Case 4: No advertising.

$$\overline{\theta}^* < 0 \qquad \underline{\theta}^* > 1$$

We believe that Case 2 is the one of most interest, based on real-world observation, and we will henceforth assume that the parameters support this outcome. But we recognize that other cases, especially 1 and 3, are interesting to examine as well.

In the special case of $\gamma = 0$ and $\beta = \frac{1}{2}$, the share of single-homing and multi-homing advertisers is proportional to the share of exclusive viewers, which is the result of Ambrus and Reisinger (2006) and Anderson, Foros and Kind. We can also show that when $\sigma < 2$, some advertisers single home even when $\gamma = 1$. This is a consequence of advertiser differentiation, which produces an asymmetry in the value of advertisements on the close rather than far outlet. Also for the case of $\gamma = 1$ and $\beta = \frac{1}{2}$, the conditions for the four cases above are: case 1, $\sigma \geq 2$; case 2, $1 \leq \sigma < 2$; case 3, $0 \leq \sigma < 1$; case 4, $\sigma < 0$.

With the advertiser cutoffs defined as above, outlet profits are:

$$\Pi_1^*(\mathbf{v}) = A\overline{\theta}p_1^*(\mathbf{v}) = \frac{A}{4}\frac{(\sigma v_1^e + \gamma\sigma v^s)^2}{v_1^e + v^s} \tag{18}$$

and

$$\Pi_2^*(\mathbf{v}) = A\underline{\theta}p_2^*(\mathbf{v}) = \frac{A}{4}\frac{(\sigma v_2^e + \gamma\sigma v^s)^2}{v_2^e + v^s} \tag{19}$$

The last step in the basic model is to solve for advertiser profits by substituting into the R_1, R_2, and R_{12} functions above. For the single-homing advertisers, this produces

$$R_1^*(\theta_j, \mathbf{v}) = (\sigma - \theta_j)(v_1^e + v^s) - p_1^*(\mathbf{v}) \tag{20}$$

$$R_2^*(\theta_j, \mathbf{v}) = (\sigma - (1 - \theta_j))(v_2^e + v^s) - p_2^*(\mathbf{v}) \tag{21}$$

For multi-homing advertisers, the profit expression becomes:

$$R_{12}^*(\theta_j, \mathbf{v}) = (\sigma - \theta_j)\, v_1^e + (\sigma - (1 - \theta_j))\, v_2^e + (\sigma + \gamma\sigma - 1)\, v^s - p_1^*(\mathbf{v}) - p_2^*(\mathbf{v}) \tag{22}$$

3.5 Discussion

The equilibrium in the advertising market described above has some interesting properties that warrant discussion independent of the institutional effects to be discussed in Sections 4 and 5. We briefly discuss them here.

First, the expressions for p_k^* show that in equilibrium, the outlet prices are based on a sum of two marginal values. The first is the value from the ad being seen by all the exclusive viewers on the outlet. The second is the value of the second impression on all the switchers. It may seem surprising that *both* outlets set price as if they are making the second impression. This is a consequence of advertiser multi-homing. Recall that the prices of the two outlets do not directly influence each others' advertising demand. A price reduction by platform 1 does not affect the number of advertisers that single-home on platform 1. Instead, it converts some advertisers who previously single-homed on outlet 2 into multi-homers. For these converts, the marginal value of the ad on outlet 1 is indeed a second-impression on the switchers, plus the value of reaching outlet 1's exclusive viewers for the first time. Since each outlet acts as a monopolist on this margin between single- and multi-homers, it extracts half the surplus under uniform pricing – the standard result for a monopolist with a 45-degree demand curve.

Second, the expressions for R_1 and R_2 show that advertisers close to the endpoints earn higher profits than those in the middle. In other words, advertisers on outlet 1 see profits decrease as θ moves from 0 to $\underline{\theta}$ and advertisers on site two see profits decrease as θ moves from 1 to $\overline{\theta}$. This is because the advertisers near the endpoints can take advantage of a more targeted context on the outlet, and their ads are more effective as a result.

Third, the expression for R_{12} shows that access to targeted content has less effect on multi-homing advertisers. In the case where the two outlets are symmetric, profits for multi-homing advertisers do not depend on θ at all and hence are independent of location. These "mass market" advertisers can compensate for lack of targeted media outlets by advertising on multiple sites, and they do this even when viewers switch.

We illustrate advertiser profits in the mixed single- and multi-homing case in Figure 2. From the figure, it is clear that advertiser profits depend on the θ cutoffs, which in turn depend on the equilibrium share of exclusive viewers and switchers.

Proposition 1: More viewer switching causes less advertiser multi-homing and vice versa – the θ cutoffs shift inward when the number of switching viewers increases and outward when the number of exclusive viewers increases.

$$\frac{\partial \overline{\theta}^*}{\partial v^s} = \frac{(\gamma - 1)\sigma v_1^e}{2(v_1^e + v^s)^2} < 0 \qquad \frac{\partial \underline{\theta}^*}{\partial v^s} = \frac{(1-\gamma)\sigma v_2^e d}{2(v_2^e + v^s)^2} > 0$$

and

$$\frac{\partial \overline{\theta}^*}{\partial v_1^e} = \frac{(1 - \gamma)\sigma v^s}{2(v_1^e + v^s)^2} > 0 \qquad \frac{\partial \underline{\theta}^*}{\partial v_2^e} = \frac{(\gamma-1)\sigma v^s}{2(v_2^e + v^s)^2} < 0$$

This is in accordance with intuition: more multi-homing on one side of the market decreases multi-homing on the other.

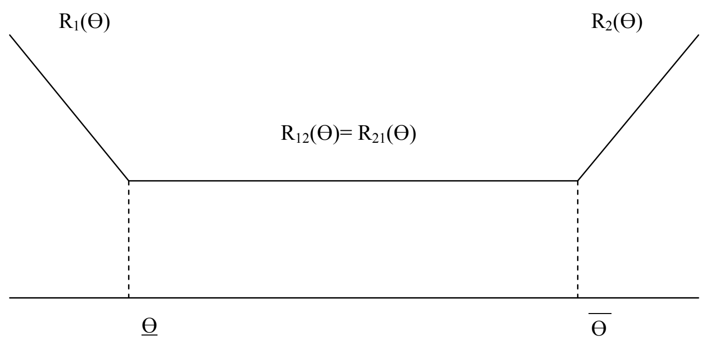

Fig. 2: Equilibrium Advertiser Profits

A few comments on γ are warranted. When γ is equal to one, repeat impressions earn advertisers the same baseline value σ as initial impressions. Exclusive viewers and switchers are equally valuable to individual outlets in this case, but total profits in the advertising market increase with viewer multi-homing, since a viewer that visits both outlets sees more ads. If σ is sufficiently high ($\sigma > 2$), even advertisers at the endpoints will advertise on both sites. At the other extreme, when $\gamma = 0$, advertisers in our model will only multi-home to capture the exclusive viewers on both sites. In this case the model collapses when all viewers switch. This is the set up in Anderson, Foros and Kind (2010).

To think about profits, it is useful first to focus on the case where institutions affect only the share of viewers who visit both sites but not market participation. In this case the effect on outlet prices of converting one exclusive viewer to a switcher will depend on the value of repeat impressions and on the shares of exclusive viewers on the two outlets.

Lemma 2: An outlet's optimum price falls with more viewer switching if repeat impressions are worth less than its share of exclusive viewers and rise otherwise.

$$\left.\frac{dp_1^*}{dv^s}\right|_{V_p} = \frac{\sigma}{2}(\gamma - \beta) \qquad \left.\frac{dp_2^*}{dv^s}\right|_{V_p} = \frac{\sigma}{2}(\gamma - (1-\beta)) \tag{23}$$

To understand the intuition, recall that this effect is happening entirely through advertiser demand given in (8). An increase in the number of switchers shifts up demand for advertising on platform 1 by an amount proportional to $\gamma\sigma \times 1$. But the corresponding loss of exclusive viewers shifts down demand by $\sigma \times \beta$. The "monopoly" price falls or rises depending on whether demand shifts down or up.

The overall effect of these demand shifts will always shift in the cutoffs between single- and multi-homing advertisers, thus reducing multi-homing.

Lemma 3: More advertisers single-home rather than multi-home when viewer switching increases without a change in viewer participation:

$$\left.\frac{d\overline{\theta}^*}{dv^s}\right|_{V_p} < 0 \qquad \left.\frac{d\underline{\theta}^*}{dv^s}\right|_{V_p} > 0 \tag{24}$$

Proof: Follows from Proposition 1 since v^s increases and v^e_k decreases. ■

Now let us consider the effect on advertisers of changes in switching. Advertisers will pay higher or lower prices according to the results of Lemma 2. They will also reach more viewers. First consider single-homing advertisers.

Lemma 4: More viewer switching, holding participation constant, increases single-homing advertiser profits for advertisers near the endpoints.

$$\left.\frac{dR_1^*(\theta_j, \mathbf{v})}{dv^s}\right|_{V_p} = (\sigma - \theta_j)(1-\beta) - \frac{\sigma}{2}(\gamma - \beta) \tag{25}$$

$$\left.\frac{dR_2^*(\theta_j, \mathbf{v})}{dv^s}\right|_{V_p} = (\sigma - (1-\theta_j))(1-(1-\beta)) - \frac{\sigma}{2}(\gamma - (1-\beta)) \tag{26}$$

In both cases, the first term gives a quantity effect, where single-homing advertisers reach more viewers due to the increased number of switchers. The second term gives the price effect discussed in Lemma 2. Since $\gamma \leq 1$, the profits of advertisers with θ_j sufficiently close to 0 or 1 will rise. Mass-market advertisers could see a drop in single-homing profits, but we will see that this only happens out-of-equilibrium because such advertisers would prefer to multi-home.

Multi-homing advertisers depend less on context and more on total viewership, so their profits definitely rise:

Lemma 5: Assuming to market is covered, multi-homing advertiser profits rise with viewer switching.

$$\left.\frac{dR_{12}^*(\theta_j, \mathbf{v})}{dv^s}\right|_{V_p} = [\theta_j\beta + (1-\theta_j)(1-\beta) - 1] + \gamma\sigma - \frac{\sigma}{2}(\gamma - 1) > 0 \quad (27)$$

The first term (in brackets) gives a change in total transport costs, which is between 0 and -1 since switchers are reached twice while exclusive viewers are only reached once. The second term is the gain of a second impression on the additional switchers. The third term gives the sum of the two price effects discussed in Lemma 2.

The change in profits with more switching is illustrated in figure 4 for the symmetric case of $\beta = \frac{1}{2}$.

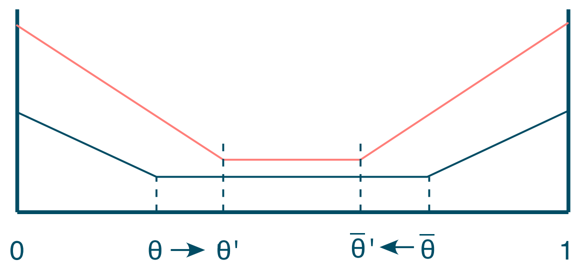

Fig. 4: Advertiser Profits with Increased Viewer Switching

Let us now turn to the profits of the outlets themselves. Outlet 1's profits are

$$\Pi_1^*(\mathbf{v}) = A\overline{\theta}p_1^*(\mathbf{v}) = \frac{A}{4}\frac{\sigma(v_1^e + \gamma v^s)^2}{v_1^e + v^s} \quad (28)$$

If the number of switchers rises while holding participation constant, there will be a decrease in the number of multi-homing advertisers, and a change in the price:

$$\left.\frac{d\Pi_1^*(\mathbf{v})}{dv^s}\right|_{V_p} = A\left.\frac{d\overline{\theta}^*}{dv^s}\right|_{V_p} p_1^*(\mathbf{v}) + A\overline{\theta}^*\left.\frac{dp_1^*}{dv^s}\right|_{V_p} \quad (29)$$

We showed in Lemma 3 that the quantity effect (the first term in (29)) is negative. So the only way that an outlet's profits could rise with increased viewer switching is if the price effect were strongly positive. From Lemma 2, we know this requires second impressions γ to be worth much more than the fraction of exclusive viewers lost β.

Proposition 2: The profits of an outlet with a small initial share of exclusive viewers β in an environment with a high value of second impressions γ could increase with viewer switching. Otherwise, outlet profits decrease. The condition for an increase is

$$2(\gamma - \beta) - \frac{v_1^e + \gamma v^s}{v_1^e + v^s}(1 - \beta) > 0 \qquad (30)$$

Proof: Differentiating (28) gives

$$\left.\frac{d\Pi_1^*(\mathbf{v})}{dv^s}\right|_{V_p} = \frac{A}{4}\sigma \left(2\frac{v_1^e + \gamma v^s}{v_1^e + v^s}(\gamma - \beta) - \left(\frac{v_1^e + \gamma v^s}{v_1^e + v^s}\right)^2 (1 - \beta)\right)$$

The sign of the bracketed term depends on the expression in (30). ■

4 Search Technology

We model search as a technology that affects viewer time costs t. The comparative statics of the viewer model can thus illustrate the positive and normative effects of new institutions that allow better searching for content.

4.1 Effect of Search Technology on Viewers

Suppose that improved search technology causes a reduction in t. This has several impacts on viewers.

Lemma 5: Lower search costs increase the cutoff between exclusive viewers and switchers:

$$\frac{\partial \hat{\alpha}}{\partial t} > 0$$

This follows naturally since less time spent on search makes it more worthwhile to incur the search cost a second time, particularly for viewers whose utility diminishes quickly. But similar logic also applies to nonparticipating viewers, some of whom will find it worthwhile to incur the search cost for the first time when t falls.

Lemma 6: Lower search costs increase the cutoff between nonparticipating and exclusive viewers:

$$\frac{\partial \alpha_0}{\partial t} > 0$$

From the two lemmas, it is clear that lower search costs increase the number of viewers in the market and also the share that visit both sites. As a result, v_1^e,v_2^e and v_s all rise when search costs fall. Moreover, the cutoff effect, which increases the number of switchers exceeds the participation effect:

Proposition 2: Lower search costs increase the number of switching viewers by more than the number of participating viewers:

$$\frac{\partial \hat{\alpha}}{\partial t} - \frac{\partial \alpha_0}{\partial t} > 0$$

Sketch of proof: The first derivative of $\hat{\alpha}$ is greater than the first derivative of α_0 at both the lower bound $t = 0$ and the upper bound $t = T/3$. Since the functions are monotonic increasing, this is enough to prove the result.

4.2 Effect of Search Technology on Advertisers

Sketch of section: The next step is to show what happens to the θ cutoffs when the viewership is affected as described above. The comparative statics are straightforward: $\overline{\theta}$ falls in v_s, while $\underline{\theta}$ rises. In other words, the cutoffs shift inward when there are more switchers so there is less advertiser multi-homing. This is in line with results in the literature that viewer multi-homing reduces the need for advertiser multi-homing. The comparative statics for exclusive viewers are the opposite, but due to Proposition 1 the switcher effect dominates.

5 Aggregators

We now add an aggregator in addition to the two outlets. An aggregator allows a viewer to "view" every outlet available using up the search time t

only once. We allow aggregators to charge a price $p_A \geq 0$ for this service, noting that the case of $p_A = 0$ has real-world relevance in many cases.

5.1 Effect of Aggregator on Viewers

In addition to using the aggregator, we continue to allow the viewer to make the three choices of the previous section: not viewing, visiting just one of the two outlets, or visiting both without making use of the aggregator. The viewer's utility maximization problem becomes

$$\max \left\{ \begin{array}{ll} U_{i1}(T-t) - \omega t & \text{visit outlet 1 only} \\ U_{i2}(T-t) - \omega t & \text{visit outlet 2 only} \\ U_{i1}\left(\frac{T}{2} - t\right) + U_{i2}\left(\frac{T}{2} - t\right) - 2\omega t & \text{visit both outlets directly} \\ U_{i1}\left(\frac{T}{2} - \frac{t}{2}\right) + U_{i2}\left(\frac{T}{2} - \frac{t}{2}\right) - \omega t - p_A & \text{use aggregator} \end{array} \right\}$$

The viewer's several options give rise to three distinct cutoff levels: (i) some viewers participate while others do not, (ii) some viewers single-home on one outlet while others visit both outlets, and (iii) some viewers use the aggregator while others use traditional search. The presence of an aggregator obviously creates the third cutoff, but if the aggregator increases utility enough, it may also affect the first and second cutoffs. We discuss these aggregator effects on viewers of first high, then intermediate, and finally low α types.

5.1.1 Effect of Aggregator on Conventional Switchers

In Section 3, we identified a cutoff value of

$$\hat{\alpha} = \frac{\omega t}{2(T/2 - t)^{1/2} - (T-t)^{1/2}}$$

between exclusive viewers who visit one outlet and switchers who view both. The switchers, those with $\alpha > \hat{\alpha}$, will use the aggregator if

$$\begin{gathered} U_{i1}\left(\tfrac{T}{2} - \tfrac{t}{2}\right) + U_{i2}\left(\tfrac{T}{2} - \tfrac{t}{2}\right) - \omega t - p_A > U_{i1}\left(\tfrac{T}{2} - t\right) + U_{i2}\left(\tfrac{T}{2} - t\right) - 2\omega t \\ 2\alpha\left(\tfrac{T-t}{2}\right)^{1/2} - \omega t - p_A > 2\alpha\left(\tfrac{T}{2} - t\right)^{1/2} - 2\omega t \\ \sqrt{2}\alpha(T-t)^{1/2} - \sqrt{2}\alpha(T-2t)^{1/2} > p_A - \omega t \\ \alpha > \tfrac{p - \omega t}{\sqrt{2}(T-t)^{1/2} - \sqrt{2}(T-2t)^{1/2}} = \tilde{\alpha} \end{gathered}$$

Note that for any $p_A < \omega t$ this expression is negative and all switchers go to the aggregator. Only if p_A is quite large do some switchers continue to use conventional search.

5.1.2 Effect of Aggregators on Switching Threshold

Those viewers who were below the cutoff $\hat{\alpha}$ in the no-aggregator model single-homed on one outlet. But if the expression derived above shows that $\tilde{\alpha} < \hat{\alpha}$, the aggregator dominates conventional search. In this case, the relevant trade-off for these viewers is whether to single-home or use the aggregator. They will use the aggregator if

$$\begin{gathered} U_{i1}\left(\tfrac{T}{2} - \tfrac{t}{2}\right) + U_{i2}\left(\tfrac{T}{2} - \tfrac{t}{2}\right) - \omega t - p_A > U_{ij}(T-t) - \omega t \\ 2\alpha\left(\tfrac{T-t}{2}\right)^{1/2} - \omega t - p_A > \alpha(T-t)^{1/2} - \omega t \\ (\sqrt{2}-1)\alpha(T-t)^{1/2} > p_A \\ \alpha > \tfrac{1}{\sqrt{2}-1}\tfrac{p_A}{(T-t)^{1/2}} = \hat{\alpha}_A \end{gathered}$$

This expression is independent of ω, since the time cost of accessing one outlet is the same as the time cost of accessing the aggregator. If the aggregator is free, then $\hat{\alpha}_A = 0$, and all participating viewers go to both outlets through the aggregator – none are exclusive to one outlet. If the aggregator's price is high enough so that $\hat{\alpha}_A > \alpha_0$ then some participating viewers will still be exclusive on one outlet, and others will use the aggregator.

5.1.3 Effect of Aggregator on Participation

Suppose that the expression above shows that $\hat{\alpha}_A < \alpha_0$. In that case, the presence of the aggregator will affect participation, since using the aggregator dominates exclusive viewing of one outlet. The relevant participation condition then becomes

$$\begin{gathered} U_{i1}\left(\tfrac{T}{2} - \tfrac{t}{2}\right) + U_{i2}\left(\tfrac{T}{2} - \tfrac{t}{2}\right) - \omega t - p_A > 0 \\ \alpha > \tfrac{1}{\sqrt{2}}\tfrac{\omega t + p_A}{(T-t)^{1/2}} = \alpha_{0A} \end{gathered}$$

We can rewrite this expression in terms of the no-aggregator participation cutoff:

$$\alpha_{0A} = \frac{1}{\sqrt{2}}\alpha_0 + \frac{1}{\sqrt{2}}\frac{p_A}{(T-t)^{1/2}}$$

This shows clearly that a free aggregator will bring more viewers into the market since $(1/\sqrt{2}) < 1$.

5.1.4 Overall Effect of Aggregators on Viewers

Depending on the utility of using the aggregator, including the aggregator's price, the cutoffs between viewing one site or two and between participating or not may both change. Thus, we can say that the number of viewers with the aggregator will obey the following inequalities:

$$v_A^s \geq v^s \qquad v_{jA}^e \leq v_j^e \qquad v_{1A} \geq v_j \qquad j = 1, 2$$

The aggregator weekly increases the number of switching viewers, and weakly decreases the number of exclusive viewers. The net effect is a weak increase in the total number of viewers of either outlet.

5.2 Effect of Aggregator on Advertisers

Sketch of Section: We have seen that the addition of an aggregator can affect viewers in a variety of ways. For now, let us focus on the case of section 5.1.2 above, where aggregators increase the number of switchers but do not affect overall participation. In this case, the results we derived in Lemmas 2–4 apply, since v_s increases but V_p remains unchanged. Then we can say that if aggregators increase switchers without increasing participation, outlet profits fall and advertiser multi-homing decreases.

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