Aggregators, Search and the Economics of New Media Institutions

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Abstract

Proliferation of content on the internet offers consumers access to more sources than had been possible with traditional media. Disaggregated content also increases the relevance of targeting for advertisers. But at the same time, search costs increase the role of intermediaries in media consumption in ways that are poorly understood. This paper studies the effects of search technology and aggregators in digital media markets. A simple model shows how these institutions can alter both market participation and the number of sites visited, which in turn affects equilibrium prices and profits in the advertising market. When consumers have a taste for variety and advertisers are horizontally differentiated, intermediaries can alter advertising strategies in ways that reduce the value of targeting. The results offer both positive and normative predictions about the value of new media institutions for consumers, advertisers and media outlets.
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Promiscuity is not a good thing in relationships, but it's a great thing in news.
- Arianna Huffington, Co-Founder & Editor-in-Chief, the *Huffington Post*[1]

1 Introduction

The "link economy" allows *more* people to consume *more* news from *more* sources than had been possible with traditional media platforms. Although comprehensive data are limited, over the past decade the share of attention to top news sites has lessened even as traditional media outlets have exited the market. This "promiscuous" media consumption has been made possible by new institutions that facilitate consumption of disaggregated content across multiple sources, namely blogs, news aggregators, and search engines. The role of these institutions in the news market continues to grow, with close to half of all visits to news sites in 2010 accessed via search and other intermediaries. The decreasing trend in the share of news visits to top sites and increasing share of visits referred by intermediaries from 2002-2010 are illustrated in Figure 1.

The effect of intermediaries on media consumption in digital markets is poorly understood. Even less is known of the effects of intermediaries on media outlets and media advertising. One reason is that the foundational models of media competition are grounded in discrete choice – all viewers choose a single platform and advertisers value only a single impression. The assumption of "single-homing" viewers has allowed for tractable models of competition through advertising levels and prices in a two-sided market framework. But two-sided market models depend crucially on single purchase assumptions, and thus cannot speak to institutions that govern visits to multiple outlets in disaggregated digital markets. On the advertising

[1] Arianna Huffington, Federal Trade Commission Workshop, *From Town Crier to Bloggers: How Will Journalism Survive the Internet Age*, Washington, DC, December 1, 2009. Remarks here: `http://www.ftc.gov/opa/2009/11/newsmedia.shtm`.

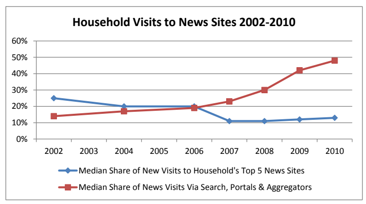

Figure 1: News Site Visits, 2002-2010. Source: Site visits from comScore, Inc. Media Metrics. News web sites from Newspaper Association of America (2010), Burrelle's Media Directory (2000), and Bulldog Reporter (2010). Search engines, aggregators and web portals from Wikipedia and comScore, Inc.

side, a crucial feature of disaggregated media markets is a greater ability to target advertisements to context.[2] Advertiser homogeneity and single purchase assumptions in foundational models abstract from this feature.

This paper adapts a two-sided market model to digital media markets. Our goal is to bring together two key features of these markets, multiple site visits by consumers and differentiated valuations by advertisers, then use the model to ask how the institutions that govern consumer behavior affect advertisers and content outlets. The starting point for our model is the fact that viewers have different appetites for variety, captured by how quickly the marginal utility of viewing diminishes as more time is spent on a given outlet. This type of viewer heterogeneity gives rise to the "switching" behavior we seek to capture, 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.

Advertisers in our model are horizontally differentiated, earning from each impression a fixed benefit less a transport cost. Advertisers close to the endpoints of a Hotelling line are those that sell products strongly associated with content on an outlet, while those in the center of the line offer more generic 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. Increased viewer switching thus offsets the benefits of access to targeted content, as the second impressions created by additional viewing are worth less to advertisers because they reach viewers at a distant site.

We model digital intermediaries as altering search costs for viewers in different ways. Search engines reduce the cost of locating content overall,

[2] According to the 2011 State of the News Media report by the Pew Research Center's Project for Excellence in Journalism, targeted display advertising is one of the fastest-growing categories of online advertising and is predicted to dominate local advertising markets. See PEJ (2011) available here: `http://stateofthemedia.org/2011/online-essay/`.

while news aggregators reduce the cost of visiting multiple sites by effectively bundling content in a single location. In this framework, we show that improved search technology increases total consumer participation in digital media markets as well as the number of sites visited. Media aggregators can have the same effects, but can also increase consumer switching without raising total market participation.

The changes in market participation relative to viewer switching drive equilibrium outcomes in our model. In the advertising market, advertisers located close to content sites place fewer but more targeted advertisements, while mass market advertisers in the center of the distribution pursue multi-homing strategies that "blanket the market" with ads to reach all consumers. Our results show that increases in consumer switching relative to participation raise the importance of targeting in the advertiser equilibrium. This occurs because as consumer multi-homing increases, a greater share of advertisers place advertisements exclusively on a single outlet with "close" content. Without aggregators, consumers switch less and a greater share of advertisers cover the market with multiple advertisements, reducing the importance of context in pricing. As in standard two-sided models with homogenous advertisers, institutions that increase consumer switching benefit all advertisers by increasing competition for ad placement and lowering prices. But advertisers with access to targeted content see the largest gains, as they can benefit from a larger audience without purchasing more ads.

Media outlets in our model earn profits from selling viewer impressions to advertisers. To simplify the analysis and maintain focus on the effects of viewer multi-homing on targeted advertising, we take the outlet market share for single-homing viewers to be exogenous. One interpretation is that viewers visiting only one media outlet choose the one that corresponds to their home city. With exogenous market shares, outlet pricing decisions play no direct role in the number of viewers at each site, allowing us to assume the advertising cost to viewers at each outlet is equal, or more simply zero. This assumption allows us to develop microfoundations for multi-homing and examine its consequences for ad targeting without simultaneously accounting for competition for exclusive viewers. [3] With this framework, the effect of aggregators on news outlets in our model is mixed. Overall, the decline in advertising demand created by consumer switching reduces profits of media outlets. But when media firms are highly asymmetric in the share of exclusive viewers, institutions that increase consumer switching can raise profits of small firms. Aggregators in this way benefit small media firms at the expense of large ones.

We also highlight an important result for advertising demand: as is typical in two-sided market models, more consumer multi-homing reduces advertiser multi-homing in equilibrium. This reduces market demand for advertising (and outlet profits) *even when aggregators do not accept ads.* Increased market participation can offset the demand effect under some parameter values, but the result nonetheless suggests an important element in the active debate on whether aggregators "steal" advertising from content sites.

This paper contributes to several themes in the literature of media and advertising. Our basic model owes much to the two-sided market analysis of media developed by Anderson and Coate (2005) and Gabszewicz et al. (2004). 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 two-sided market models studied outcomes with single-homing readers and multi-homing advertisers. (An exception is Serfes (2006), which considered media location choice.) Recent working papers by Ambrus and Reisinger (2006) and Anderson, Foros and Kind (2011) develop richer models that allow viewers to consume multiple products. These models offer predictions more in line with stylized facts, but the focus remains on advertising prices and quantities rather than the institutions of digital media markets. More closely related to this paper is Athey, Calvano and Gans (2010), which also abstracts from the nuisance

[3] Athey, Calvano and Gans (2010) take a similar approach, assuming exogenous market share for single-homing viewers and zero advertising cost to consumers. Because outlets do not compete for viewers in advertising quantities, by some definitions such models are not strictly two-sided, for example per Hagiu (2007), but the emphasis on multi-homing and competition for advertisers speaks to important topics in the two-sided market literature.

cost of advertising to focus squarely on the implications of multi-homing. Their focus, however, is on the capacity expansion effect of multi-homing in institutional environments that differ between on-line and off-line media, where our analysis centers on how multi-homing driven by intermediaries affects differentiated advertisers.

The paper also contributes to a growing literature on targeted advertising. Early work in this area by Iyer, Soberman, and Villas-Boas (2005) considers 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 targeting technology. Both Athey, Calvano and Gans (2010) and Bergemann and Bonatti (2011) study the implications of targeting technology for competition between online and offline media. As noted above, Athey, Calvano and Gans (2010) focus on how tracking technology can effectively create advertising capacity. Bergemann and Bonatti instead highlight the role of targeting in segmenting the advertising market.

Although the modeling approach we take here is quite different, we share with Bergemann and Bonatti (2011) an emphasis on the importance of advertiser heterogeneity in digital markets relative to traditional markets. In their work, the concentration of differentiated viewers leads to softer competition among different advertisers, so targeting leads to lower advertising prices and higher valuations. In our model, advertisers with access to targeted media also earn more from each advertisement, but consumer multi-homing can offset this targeting effect.

More generally, both Athey, Calvano and Gans (2010) and Bergemann and Bonatti (2011) consider the equilibrium allocation of advertisers across on-line and off-line media. Our model, by contrast, emphasizes advertiser heterogeneity in the relationship between advertised products and content viewers wish to consume. In doing so, we can speak to the types of advertisers most likely to benefit from internet technology in general and new media institutions in particular.

The advertiser transport costs in our model also offer a natural way of thinking about advertising *context*, where an advertising impression on the same viewer has a higher value to a particular advertiser on some sites than on others. Contextual valuation is central to evaluating the benefits of tracking technology, which places the same advertisement in front of the same consumer in different environments. Furnham, Gunter and Richardson (2002) show in a laboratory setting that context affects recall, while Goldfarb and Tucker (2011) show that viewer behavioral data can substitute for lack of contextual targeting. In our model, tracking is profitable when the loss in value of an impression in a disadvantageous context is not too large, and the value of repeat impressions is not too small. A full theoretical treatment of ad tracking would incorporate tradeoffs between targeting viewer types as well as content types, which might be done by incorporating horizontally differentiated viewers in our model. Understanding this tradeoff, as well as the more general potential for positive and negative spillovers from advertisements to content, offer promising avenues for future work.

A related literature focuses on how targeting affects production decisions of media outlets. Taylor (2011) considers the role of media quality in holding attention, showing how quality investments by media firms can generate exclusive viewership and hence market power over advertises. Gal-Or et al. (forthcoming), studies how heterogeneous advertiser demand for differentiated viewers affects product positioning of media firms. Incorporating media location choices into our differentiated advertiser framework offers an interesting area for future work along these lines.

Lastly, a small literature examines the role of aggregators directly. De Smet (2011) models aggregators as "meta-platforms" that aggregate one side of a two-sided market. The paper emphasizes the role of aggregating platforms in the vertical production chain, an interpretation that is relevant here. Dellarocas, Katona & Rand (2010) consider aggregators in a model of networks, where the aggregator selectively chooses high quality content. Empirically, Chiou and Tucker (2011) show that temporary removal of Associated Press (AP) content from Google News reduced consumer demand for content from AP sources.

The paper proceeds as follows. Section 2 develops the basic model of viewers, advertisers and outlets and derives the equilibrium. Section 3 examines the role of aggregation and search on viewers, and section 4 examines the effect of these intermediaries on advertisers and outlets. Section 5 discusses applications and concludes the paper.

2 Model

2.1 Viewers

A market is characterized by a total of V potential viewers, each with an equal endowment of time T available for viewing content on media outlets. Each viewer i receives utility for spending time T_{ik} on outlet k according to $U(T_{ik}, \alpha_i)$, where α_i is a viewer type parameter uniformly distributed on [0,1]. We assume that this utility function has the properties

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

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 with high values of α_i thus have greater taste for variety. 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 $U(T_{ik}, \alpha_i) = \alpha_i T_{ik}^a$, $a \in (0, 1)$, which has these properties.

Searching for an outlet causes disutility of search effort t. 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 cost t once, while choosing both outlets incurs it twice. Each viewer thus solves

$$max \{0, U(T, \alpha_i) - t, U(T/2, \alpha_i) - t + U(T/2, \alpha_i) - t\}$$

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. For the specific utility function $U(T_{ik}, \alpha_i) = \alpha_i T_{ik}^a$, the cutoff for participation is

$$\begin{aligned} \alpha_i T^a - t &\geq 0 \\ \alpha_i &\geq \frac{t}{T^a} = \alpha_0 \end{aligned}$$

The cutoff between viewers who visit two outlets versus one is

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

Note that our assumption of diminishing marginal utility requires $0 < a < 1$, so $2^{1-a} - 1$ also lies between 0 and 1. 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 assume that t is small enough to support $\hat{\alpha} < 1$.

The "exclusive" viewers only visit one outlet, and we need to determine which one. 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.[4]

Tie-Breaking Assumption: Of the exclusive viewers (those with $\alpha_i < \hat{\alpha}$) 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

[4]In typical single-homing models of media, the market share β would be determined in part by competition in advertising quantities. Because introducing competition in ad levels would significantly complicate the analysis without adding insight into the effects of endogenous multi-homing, we abstract from this aspect of competition and assume fixed market shares for any single-homing viewers.

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 outlets 1 and 2 respectively:

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

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

This result will be important in our analysis of institutions, because some institutional changes affect the switching threshold, $\hat{\alpha}$, without altering participation, α_0.

The viewer model just described explains the number of exclusive and switching viewers of each outlet. These outcomes are all that matter for advertiser behavior and outlet profits. We will return to the viewer model in Sections 4 and 5 when we investigate how search and aggregators affect viewers. But first, we use the viewer outcomes v_1^e, v_2^e, and v^s as inputs into a model of advertisers and content outlets.

2.2 Advertisers

There are A advertisers who seek to place advertisements in front of viewers. Advertisers are horizontally differentiated, 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 wine merchant adjacent to a restaurant review or cosmetics manufacturer at a fashion article. 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 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.[5] The payoff to multi-homing 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 outlet 1. The second term is the additional payoff from reaching the exclusive viewers on outlet 2. Depending on the advertiser's location θ_j, one of these payoffs will be higher than the other. The third term is the

[5]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 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.

payoff from making both a first and second impression on the *switchers*. Some comments on this third term are warranted.

It is reasonable to expect that $0 < \gamma < 1$, with repeated impressions worth less than initial impressions but greater than zero.[6] 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 wine and lipstick. Both wine merchants and cosmetic manufacturers value impressions on this woman wherever she visits. But when the context for advertising matters, a wine impression is more likely to convert to a wine sale when the woman views the ad adjacent to a restaurant review than when she views the ad reading an article on fashions. 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 versus single-homing are

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

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

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

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

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

The cutoffs above are illustrated in Figure 2. 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

[6] A substantial body of research tackles the question of estimating the number of unique and repeat impressions on the internet from page view data, but specific estimates of γ are not common. See Danaher (2007) for insight on estimation.

access to content "close" to their product would be expected to take advantage of these targeted sites while mass advertisers must reach consumers by placing ads at multiple locations. A few observations are warranted. Higher advertiser payoffs for single or repeat impressions shift the cutoffs outward, increasing advertiser multi-homing. 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. The intuition that viewer switching has the effect of a price increase on advertiser demand foreshadows the equilibrium effects derived below.

Figure. 2: Advertiser Multi-homing in Product Space

2.3 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

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

while demand on outlet 2 is

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

Notice that an outlet's demand function does not depend on its 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.

In principle, there are four possible equilibrium outcomes for advertisers. They are (i) all advertisers multi home – $\overline{\theta}^* \geq 1$ and $\underline{\theta}^* \leq 0$; (ii) some advertisers single home, others multi home – $\frac{1}{2} \leq \overline{\theta}^* < 1$ and $0 < \underline{\theta}^* \leq \frac{1}{2}$; (iii) some advertisers single home, others do not advertise – $0 \leq \overline{\theta}^* \leq \frac{1}{2}$ and $\frac{1}{2} \leq \underline{\theta}^* \leq 1$; and (iv) no advertising – $\overline{\theta}^* < 0$ and $\underline{\theta}^* > 1$.

We believe that case (ii), where some advertisers single-home and others multi-home, is the one that best comports with 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.

The outlets choose price p_1 and p_2 to maximize

$$\Pi_1 = A\overline{\theta}p_1 \tag{10}$$

and

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

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:

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

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

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 (2011).

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

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

and

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

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 (2011). 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 (2011).

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

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

and

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

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:

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

2.4 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 3 and 4. We briefly discuss them here.

First, the expressions for p_k^* show that in equilibrium, the outlet ad 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 outlet 2 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. This result contrasts with standard two-sided models with homogenous advertisers where viewer multi-homing and advertiser multi-homing move in direct proportion. An interesting empirical prediction is that advertisers without access to targeted context are more likely to pursue multi-homing strategies.

We illustrate advertiser profits in the mixed single- and multi-homing case in Figure 3. 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.

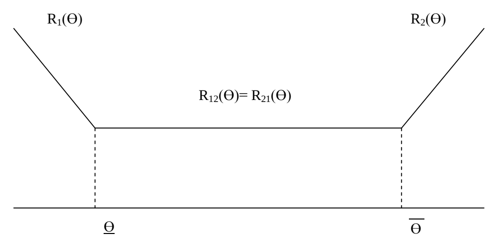

Figure. 3: Equilibrium Advertiser Profits

We have now presented a viewer model that takes viewer types and utility as inputs and produces viewership levels **v** as outputs. Then we analyzed a profit-maximizing Nash equilibrium between two outlets setting prices to advertisers. The outcomes of this Nash equilibrium depend on the viewership levels.

The remainder of the paper is organized in two sections. Section 3 discusses the institutional consequences of improved search and the advent of aggregators. We will show, in the context of our viewer model, how these affect the viewership levels $\mathbf{v}$. Section 4 analyzes how these changes in viewership levels affect the equilibrium advertiser prices, behavior of advertisers, and the profits of the content outlets. The main comparative statics question of Section 4 is under what conditions the outlets would be better or worse off with the two different technology changes.

3 Search, Aggregators, and Viewers

General improvements to search technology and entry of a content aggregator work differently. Search is a technology that allows viewers to find content more easily. Regardless of what other content a viewer may access, improved search reduces the *incremental* cost of finding new content. In our viewer model, this can be seen as a reduction in parameter t.

Aggregators work differently. Once viewers have accessed an aggregator, they are able to see simultaneously the content offerings of multiple outlets. In most cases the viewer must still "click through" to access the full content of each outlet, but other than this single click, there is no further search involved. In the viewer model, viewers incur search cost t in order to reach the aggregator, but at that point they can immediately see the content offerings of both outlets without incurring any additional search costs.

In essence then, search technology decreases the cost of reaching additional content on the margin, while aggregators involve a single "fixed" cost of reaching a multitude of content without searching. Using an aggregator is usually not as simple as navigating directly to a content outlet. This may be because the aggregator charges a fee, or there may be learning and setup costs to using the aggregator. In many cases, the aggregator may be less visually appealing than the content outlet itself. All of these suggest some additional fixed cost of using the aggregator, which we denote by p_A.[7]

[7] In a decentralized content market, newspapers or other traditional media firms are aggregators in the sense modeled here, so p_A may in this case be considered a paywall price.

3.1 Search and Viewers

Suppose there were an improvement in search technology that lowered t. Changes in t impact the whole distribution of viewers, nonparticipants, exclusive viewers, and switchers, so could potentially cause any group to change behavior. In terms of the viewer model presented in Section 3, a change in t will impact the market participation cutoff α_0, as some additional viewers will find it worthwhile to incur the search cost of finding content. Also, some viewers will find that a lower t makes it more worthwhile to incur the search cost a second time, particularly for viewers whose utility diminishes quickly.

Lemma 2: Lower search costs decrease the cutoff between nonparticipating and exclusive viewers. Thus total participating viewers increase.

$$-\frac{\partial \alpha_0}{\partial t} = -\frac{1}{T^a} < 0 \Rightarrow \frac{\partial v_k}{\partial t} > 0$$

Lemma 3: Lower search costs decrease the cutoff between exclusive viewers and switchers. Thus the number of switching viewers increases.

$$-\frac{\partial \hat{\alpha}}{\partial t} = -\frac{1}{(2^{1-a} - 1)T^a} < 0 \Rightarrow \frac{\partial v^s}{\partial t} > 0$$

From the two lemmas, it is clear that higher search costs decrease both the number of switching viewers and the number of participating viewers. The key question that remains is what happens to the number of exclusive viewers. We can glean a mathematical answer from our model, but the intuition is clear: since switchers incur more search costs, their cutoff moves more than for participation. This means that lower search costs will increase switching by more than the increase in participation, and thus exclusive viewers will decrease.

Lemma 4: Lower search costs decrease cutoff $\hat{\alpha}$ by more than cutoff α_0.

Thus, exclusive viewers fall.

$$-\frac{\partial\hat{\alpha}}{\partial t} < -\frac{\partial\alpha_0}{\partial t} \Rightarrow \frac{\partial v_k^e}{\partial t} < 0$$

Proof: Compare the expressions in Lemmas 2 and 3. As noted earlier, since $0 < a < 1$, $2^{1-a} - 1$ is also between 0 and 1. ■

This participation effect of search technology can be defined more usefully in percentage terms:

Definition: The *participation effect* of an improvement in search technology causes the change in exclusive viewers to be η percent as large as it would be without the participation effect, where

$$\eta = \frac{\frac{\partial\hat{\alpha}}{\partial t} - \frac{\partial\alpha_0}{\partial t}}{\frac{\partial\hat{\alpha}}{\partial t}} = 2 - 2^{1-a} < 1 \tag{23}$$

Note that parameter a expresses how rapidly utility diminishes in time for all types of viewers, and as a falls, η falls too. In a sense, a lower a population is one that is more "impatient" and therefore places a higher value on viewing multiple outlets rather than a single one.

Since the change in the number of switchers is

$$-\frac{\partial v^s}{\partial t} = \frac{\partial\hat{\alpha}}{\partial t}V > 0,$$

we can use the tiebreaker assumption and the definition of η to write the change in exclusive viewers of each outlet as:

$$-\frac{\partial v_1^e}{\partial t} = -\eta\beta\frac{\partial\hat{\alpha}}{\partial t}V \qquad -\frac{\partial v_2^e}{\partial t} = -\eta(1-\beta)\frac{\partial\hat{\alpha}}{\partial t}V$$

The important conclusion here is that improved search technology will have two effects. It will cause some previously nonparticipating viewers to become exclusive viewers, and it will cause some previously exclusive viewers to become switchers. There will be less-than-complete "replacement" of the lost exclusives by new exclusives, and this depends on fraction η.

3.2 Aggregators and Viewers

As discussed above, an aggregator is different from search because an aggregator introduces a new way of viewing content that is different from any of the options available with search. Those previous options were: not viewing, visiting just one of the two outlets, or visiting both without making use of the aggregator. We now add, in addition, the possibility of paying the search cost plus the aggregator price p_A one time and thereby gaining access to both content outlets simultaneously. This changes the viewer's utility maximization problem to

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

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. In principle, this third cutoff could be greater or less than either of the previous two cutoffs. It will depend on the utility that the aggregator gives to viewers, which in turn depends on the aggregator price p_A and the other parameters.

The important conclusion here is that an aggregator adds a new option. This new option will only be attractive to particular types of viewer. If it is attractive only to switchers, then it cannot change the number of exclusives. If it is attractive only to previous switchers and exclusives, then it cannot change the number of participants.

Based on current real-world experience, we believe that the case where the aggregator cutoff affects some previously-exclusive viewers is the most relevant. To the extent that nonparticipating viewers decide to participate, they are likely to begin viewing a single outlet, probably by using a search engine. It is unlikely that a viewer would move straight from nonparticipation to using an aggregator. Thus, it appears to us that the most relevant case is where the aggregator changes the switching threshold.

Those viewers who were below the cutoff $\hat{\alpha}$ in the no-aggregator model were exclusive viewers on one outlet. But suppose that for some of these viewers, 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

$$U\left(\tfrac{T}{2}, \alpha_i\right) + U\left(\tfrac{T}{2}, \alpha_i\right) - t - p_A > U(T, \alpha_i) - t$$
$$\alpha_i > \tfrac{p_A}{(2^{1-a}-1)T^a} = \hat{\alpha}_A$$

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. We assume 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.[8]

This creates an important difference between aggregators and search improvements. A search improvement will move two cutoffs at once, increasing both participation and switching. An aggregator will move only one cutoff. In what we believe is the most plausible case, aggregators increase switching but not participation.

3.3 Viewer Welfare Gains

Both a search improvement and the addition of an aggregator will increase viewer utility. In the case of search, the increases accrue to all viewers who choose to participate. For an aggregator, the gains accrue to all viewers above the $\hat{\alpha}_A$ cutoff – that is, to those with greatest taste for variety.

To compare the viewer welfare gains from search improvements to those from aggregators requires some method to make the two equivalent. One way to proceed is to consider a comparison between search improvements and an aggregator that have the same effect on the switching threshold. Specifically, suppose there were a change in search costs from t to t' that reduced the cutoff between switchers and exclusives from $\hat{\alpha}$ to $\hat{\alpha}'$ and the cutoff between exclusives and nonparticipants from α_0 to α_0'. Compare this to the introduction of a hypothetical aggregator that has price $p_A = t'$

[8] It is important to keep in mind that p_A need not be a money price; it can be a setup or convenience cost.

which gives an aggregator cutoff $\hat{\alpha}_A = \hat{\alpha}'$.

Proposition 1: The sum of consumer welfare increases more from a search improvement from t to t' than from the introduction of an aggregator with price $p_A = t'$.

Proof: For viewers who do not switch after a search improvement or introduction of an aggregator, the sum of increased utility is

$$\int_{\alpha_0'}^{\alpha_0} (U(T,\alpha) - t')d\alpha + \int_{\alpha_0'}^{\hat{\alpha}'} [(U(T,\alpha) - t') - (U(T,\alpha) - t)]d\alpha$$

The sum of increased utility from the aggregator is 0 since these viewers do not use the aggregator.

The increased utility for those who switch after an improvement in search receive an increased sum of utilities equal to

$$\int_{\hat{\alpha}'}^{\hat{\alpha}} [(2U(T/2,\alpha) - 2t') - (U(T,\alpha) - t)]d\alpha$$
$$+ \int_{\hat{\alpha}}^{1} [2U(T/2,\alpha) - 2t') - (2U(T/2,\alpha) - 2t)]d\alpha$$

For those who switch after the introduction of an aggregator , the increased sum of utilities is

$$\int_{\hat{\alpha'}}^{\hat{\alpha}} [(2U(T/2,\alpha) - t - p_A) - (U(T,\alpha) - t)]d\alpha$$
$$+ \int_{\hat{\alpha}}^{1} [2U(T/2,\alpha) - t - p_A) - (2U(T/2,\alpha) - 2t)]d\alpha$$

These expressions are very similar. If $p_A = t'$, then the search improvement is better for users by the difference

$$\int_{\alpha_0'}^{\alpha_0} (U(T,\alpha) - t')d\alpha + \int_{\alpha_0'}^{1} (t - t')d\alpha$$

Since $t' < t$ by construction, this is positive. ■

Of course, the above result only applies if the aggregator happens to have price $p_A = t'$. If the price were lower, then $\hat{\alpha}_A$ would be lower and payoffs to high-α users of the aggregator would increase. At some point, if p_A were low enough, the aggregator would increase the sum of viewer utility by more than a given search improvement.

4 Search, Aggregators, Advertisers, and Outlets

We have seen in the previous section that improvements in search or the addition of an aggregator will cause changes in the numbers of exclusive and switching viewers. We now examine how these changes affect advertisers and outlets.

We saw that both a search improvement and an aggregator result in a change in the number of switching viewers, although this change may not be equal for the two cases. To make a more even comparison, consider a change in the aggregator price that increases the number of switching viewers by δ. We know that this will cause a corresponding decrease in the number of exclusive viewers of outlet 1 equal to $\beta\delta$ and a decrease in exclusive viewers of outlet 2 equal to $(1-\beta)\delta$.

Let us also consider an equivalent change in search technology that also increases switching viewers by δ. Because of the participation effect, the corresponding change in exclusive viewers will be $\eta\beta\delta$ on outlet 1 and $\eta(1-\beta)\delta$ on outlet 2.

4.1 Advertising Prices

First we determine how equilibrium advertising prices change when the number of viewers changes.

Lemma 5: An increase in the number of exclusive viewers increases an outlet's optimal advertising price. An increase in the number of switching viewers (all else equal) increases an outlet's optimal advertising price, but by less to the extent that repeat impressions are worth less.

$$\frac{\partial p_1^*}{\partial v_1^e} = \frac{\sigma}{2} \qquad \frac{\partial p_2^*}{\partial v_2^e} = \frac{\sigma}{2} \tag{24}$$

$$\frac{\partial p_1^*}{\partial v^s} = \frac{\gamma\sigma}{2} \qquad \frac{\partial p_2^*}{\partial v^s} = \frac{\gamma\sigma}{2} \tag{25}$$

We can use this result to compare the effects of a search improvement versus an aggregator:

Proposition 2: If a search improvement and an aggregator both increase switchers by δ, the equilibrium advertising price may rise or fall depending on the initial share of exclusive viewers and the value of second impressions. The price always rises more (or falls less) from the search improvement relative to the aggregator.

Proof: An aggregator changes the advertising price of outlet 1 according to

$$dp_1^{*a} = \frac{\partial p_1^*}{\partial v^s}\delta + \frac{\partial p_1^*}{\partial v_1^e}(-\beta\delta) = \frac{1}{2}\sigma\left(-\beta + \gamma\right)\delta \tag{26}$$

while a search improvement changes it according to

$$dp_1^{*s} = \frac{\partial p_1^*}{\partial v^s}\delta + \frac{\partial p_1^*}{\partial v_1^e}(-\eta\beta\delta) = \frac{1}{2}\sigma\left(-\eta\beta + \gamma\right)\delta \tag{27}$$

The price rises for $\beta < \delta$ and falls otherwise for outlet 1. The reverse is true for outlet 2. The effect is always more positive for search technology because of the participation effect captured by $\eta < 1$. ■

This result is important to understanding how search improvements and aggregators affect outlets. To understand the intuition, recall that an increase in exclusive viewers comes from an increase in viewer participation. But an increase in switching viewers on, say, outlet 1 has two effects. It shifts up demand for advertising on outlet 1 by an amount proportional to $\gamma\sigma \times 1$. But there is also a corresponding loss of exclusive viewers that shifts down demand by $\sigma \times \beta$. The "monopoly" price rises or falls depending on whether demand shifts up or down.

4.2 Advertiser Homing Behavior

Next we turn to how changes in the number of viewers and the resulting changes in prices affect the cutoffs between advertiser single- and multi-homing.

Lemma 6: 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.

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

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

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

Proposition 3: If a search improvement and an aggregator both increase switchers by δ, more advertisers will single-home, and the increase in single-homing will be larger from the aggregator than from the search improvement.

Proof: An aggregator changes the left-hand advertiser multi-homing cutoff by

$$d\overline{\theta}^{*a} = \frac{\partial\overline{\theta}^*}{\partial v^s}\delta + \frac{\partial\overline{\theta}^*}{\partial v_1^e}(-\beta\delta)$$

and a search improvement changes it by

$$d\overline{\theta}^{*s} = \frac{\partial\overline{\theta}^*}{\partial v^s}\delta + \frac{\partial\overline{\theta}^*}{\partial v_1^e}(-\eta\beta\delta)$$

Lemma 6 shows that both expressions are negative, but since $\eta < 1$, the latter expression is smaller in magnitude. The logic is the same for the right-hand cutoff. ■

This is an example of the Rochet and Tirole (2003) result that more multi-homing on one side of the market causes more single-homing on the other side. An aggregator causes proportionately more switching by viewers since there is no participation effect to offset the switching effect.

The overall effect on advertisers is threefold. All advertisers will reach more viewers. More advertisers will multi-home. Advertisers will pay higher or lower prices according to the results of Proposition 3. If we consider the case of symmetric outlets ($\beta = 1/2$) and second impressions worth more than 1/2, then advertising prices fall and the situation appears as in Figure

4.

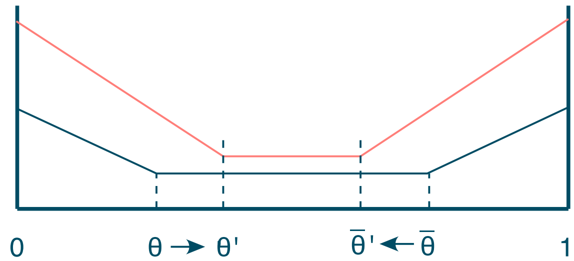

Figure 4: Advertiser Profits with Increased Viewer Switching, Symmetric Outlets, Second Impressions worth at least Half of First Impressions

4.3 Content Outlet Profits

Let us now turn to the profits of the outlets themselves. Content outlet profits are the product of advertising prices and the demand for advertising, and this product can be expressed, for outlet 1, as

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

Then the effect of changes in the number of viewers works as follows:

Lemma 7: An increase in the number of exclusive viewers on an outlet increases that outlet's profits. An increase in the number of switching viewers also increases an outlet's profit, but by less.

Proof:

$$\frac{\partial \Pi_1^*}{\partial v_1^e} = \frac{A\sigma}{4}\frac{v_1^e + \gamma v^s}{v_1^e + v^s}\left(2 - \frac{v_1^e + \gamma v^s}{v_1^e + v^s}\right)$$

$$\frac{\partial \Pi_1^*}{\partial v^s} = \frac{A\sigma}{4}\frac{v_1^e + \gamma v^s}{v_1^e + v^s}\left(2\gamma - \frac{v_1^e + \gamma v^s}{v_1^e + v^s}\right)$$

Similar results hold for outlet 2. ■

Now we can prove our main result about the overall impact of a search improvement or an aggregator on content outlet profits:

Proposition 4: If a search improvement and an aggregator both increase switchers by δ, the change in content outlet profits is more positive for the search improvement than for the aggregator. The profits of a content outlet with a large share of exclusive viewers (high β for outlet 1) will fall, while the profits of a content outlet with a small enough share of exclusive viewers (low β for outlet 1) will rise.

Proof: If switchers increase by δ, an aggregator changes the profit of outlet 1 according to

$$d\Pi_1^{*a} = \frac{\partial \Pi_1^*}{\partial v^s}\delta + \frac{\partial \Pi_1^*}{\partial v_1^e}(-\beta\delta) \tag{29}$$

while a search improvement changes it according to

$$d\Pi_1^{*s} = \frac{\partial \Pi_1^*}{\partial v^s}\delta + \frac{\partial \Pi_1^*}{\partial v_1^e}(-\eta\beta\delta) \tag{30}$$

In each expression, the first term is positive and the second negative, so for any $\eta < 1$, $d\Pi_1^{*a} < d\Pi_1^{*s}$. From Lemma 7, the profit gain from one additional switching viewer is smaller than the profit loss from one less exclusive viewer by an amount proportional to the value of second impressions γ. Thus, if $\beta = 1$ or $\eta\beta = 1$ expressions $d\Pi_1^{*a}$ and $d\Pi_1^{*s}$ are negative, respectively. Holding γ constant, as β falls, both expressions rise. Thus for small enough β, $d\Pi_1^{*s} > 0$ and for an even smaller β, $d\Pi_1^{*a} > 0$. ■

The overall intuition of this section is that both search and aggregators increase switching viewers and decrease exclusive viewers, but the decrease in exclusive viewers is smaller for search improvements because of the participation effect. These changes always decrease advertiser multi-homing, but an outlet's equilibrium advertiser price may rise or fall depending on its share of exclusive viewers and on the value of second impressions. For outlets with a high share of exclusive viewers, the overall effect is to reduce the equilibrium advertising price and thus reduce overall profits. But for an outlet with a low enough share β, the additional second impressions can more than offset the (small) loss of exclusive viewers, raising the equilibrium advertising price, and even raising profits.

5 Discussion and Conclusions

The results above suggest a few important insights relevant to future work. First, the costs of locating disaggregated content and the institutions that affect these costs are central to consumption in digital media markets. When consumers have an appetite for variety, the costs imposed by search can determine the number of outlets that viewers visit as well as the total number of participants in the market. These search costs drive consumer welfare.

Because search costs affect consumer multi-homing, institutions that affect viewer behavior are important in determining equilibrium advertising prices and the relevance of ad targeting. Search engines and aggregators in this way also affect the advertising strategies of heterogenous firms. For outlets, institutions that increase the number of sites visited by consumers benefit small media outlets at the expense of large ones.

It is worth noting that in our model, search costs and search technology are exogenous and passive. But in practice, the strategic incentives of search firms may play a substantial role in the market outcome. In particular, our model suggests that the incentive of a search engine is not necessarily to minimize search costs. Specifically, we show in section 4 that higher t can increase both advertiser demand and outlet profits. A profit-maximizing search engine might seek these rents through manipulation of search costs. Understanding the strategic choice of t and the effect of search engine competition on this choice is a fruitful avenue for future research.

A second contribution of our model is to formalize the role of aggregators in digital media markets and distinguish outcomes with these institutions from consumption based solely on search. The crucial difference is that aggregators under some parameter values can increase multi-homing without increasing participation, while search technology always alters both margins. In this parameter space, increased consumer multi-homing reduces overall demand for advertising. In so doing, it also reduces the profits of media outlets, particularly large ones. It is worth emphasizing that this result is due solely to consumer multi-homing – it occurs even when aggregators do not sell ads.

A more subtle result is that when aggregators reduce advertiser multi-homing in this way, the value of context becomes more salient in the advertiser market. In other words, when advertisers single-home, the highest surplus is earned by those "close" to content sites. Thus competition for advertisers is likely to be more focused on contextual matches when aggregators are important in the market. This is an empirical question worthy of more detailed treatment. Another interesting launch point for future study is the extent to which these contextual surpluses attract entry by media outlets.

Also following the arguments above, our model indicates that when consumers have an appetite for variety but face costly search, institutions will emerge to enable multi-homing. The positive aggregator price p_A attests to this. But because entry in the aggregator market is likely to be free, or close to it, it is natural to consider how competition in aggregation affects outcomes. A natural way of extending our model would be to expand the number of outlets and introduce horizontal differentiation on the viewer side. Another useful extension would be to consider the boundaries of the aggregator in an environment with more than two outlets. This question is reminiscent of work on the theory of the firm, but where the transaction costs that govern integration are on the consumer rather than producer side.

In sum, we offer here a first attempt to model key features of digital media markets – taste for variety, costly search, and heterogeneous advertisers – none of which are captured in the two-sided market models typically applied to media. We use our model to study the institutions that have emerged to mediate news consumption on the internet, namely aggregation and search. The key feature that distinguishes these institutions is how transaction costs matter. Both aggregators and improved search tend to increase viewer multi-homing, but unlike search, aggregators may not increase the number of viewers in the market. The implications for outlets and advertisers follow from this: greater consumer multi-homing without higher participation reduces the demand for advertising overall, to the detriment of outlets, especially large ones. The tendency of advertisers to multi-home falls, and competition for advertisers moves away from mass market toward niche firms. We have much to learn about the nature of competition in these markets, but our results suggest many avenues for future exploration.

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