Aggregators, Search and the Economics of New Media Institutions

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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 costs a potentially important driver of consumer behavior. This paper studies the effect of search technology and aggregators on heterogeneous 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 consumers have a taste for variety and advertisers are horizontally differentiated, new media institutions alter the advertising strategies of mass market and niche advertisers. 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 Introduction

Arianna Huffington’s case for the “link economy” conveyed by this quote rests on the idea that blogs and other information aggregators allow more people to consume more news from more sources than traditional media platforms. The idea that new media institutions facilitate what the economic literature has come to call multi-homing has intuitive appeal and is supported by usage data.

Less clear is how the institutions of the link economy affect media outlets and the advertising market. Two-sided media models that build on Anderson & Coate (2005) are based on platform competition for single-homing consumers, whose ad views are then sold by media outlets to undifferentiated advertisers. If the assumption of single-homing consumers seemed unsatisfactory in traditional media, it fails entirely in the disaggregated markets of the link economy. The assumption of homogenous advertisers similarly masks an essential feature of decentralized content markets – ad placement across differentiated content outlets is a strategic decision for advertisers. The technology of ad tracking in particular, which allows advertisements to follow consumers across multiple sites, presumes a positive value for repeat impressions across differentiated content sites that is not captured by standard models.

This paper adapts a two-sided market model to digital media markets. Our goal is to capture key features of consumption in digital markets, then use the model to ask how the institutions that govern consumer behavior affect advertisers and content outlets. The institutions that we consider are

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2 For example, in May 2008, media viewers in a sample of internet users tracked by ComScore viewed on average 6.78 media sites with a standard deviation of 6.91 sites.
internet search and aggregation. The starting point for our model is the fact that “promiscuous” media consumption on the internet fundamentally requires search, and we model search engines as altering the transaction costs of locating content. Against this benchmark case of costly search, we model aggregators as reducing the cost to consumers of visiting multiple sites. For expositional clarity, we refer to consumer multi-homing as “switching” throughout the paper.

We show that improved search technology affects total consumer participation in digital media markets as well as the number of sites visited, unambiguously raising consumer surplus. Media aggregators can have the same effects, but differentially benefit viewers with greater appetite for variety. For some parameter values, aggregators increase consumer switching without raising total market participation. We emphasize this case throughout the paper to better distinguish the effects of consumer switching on market participants.

We introduce advertiser heterogeneity to explore how changes in consumer behavior alter the market for targeted advertising. In general, advertisers located “close” to content sites place fewer but more targeted ads, while mass market advertisers in the center of the distribution pursue multi-homing strategies that “blanket the market” to reach all consumers. We show that institutions that increase consumer switching benefit all advertisers by increasing competition for ad placement and lowering prices. But advertisers with access to “close” content see the largest gains, as they can benefit from a larger audience without purchasing more ads.

The effect of aggregators on news outlets in our model is mixed, depending critically on the initial market share for each outlet. 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. Overall, aggregators benefit small media firms at the expense of large ones.

While our modeling approach owes much to two-sided media market models developed by Anderson and Coate (2005) and Gabszewicz et al. (2006), our specification of both viewer and advertiser preferences is novel.
Viewers in our model derive utility from time spent reading content offered on atomistic web sites we call outlets. 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. 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 typical fashion of horizontal product 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 important, the value of repeat impressions is lessened due to reaching viewers on the “distant” site.

The advertiser transport costs in our model offer a natural way of thinking about advertising context, or circumstances where a single individual has a higher value to a particular advertiser on some sites than on others. This notion of context, which we interpret as heterogeneous advertiser valuation for different content attributes, is distinct from traditional notions of targeting, typically interpreted as heterogeneous advertiser valuation for different consumer attributes (often demographics). Although context is recognized as central in the advertising sales arena, it has received minimal formal treatment in psychology, marketing, or economics. Our results show that increases in consumer multi-homing triggered by aggregation or improved search raise the importance of context in the advertiser equilibrium. This occurs because as consumer multi-homing increases, a greater share of advertisers place ads exclusively on a single outlet with “close”
content. Without aggregators, consumers switch less and a greater share of advertisers blanket the market with multiple ads, reducing the importance of context in pricing.

Our model offers a framework for evaluating the benefits of ad tracking technology, which allows consumers to see the same advertisements repeatedly in different environments. Intuitively, 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 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.

We also highlight an important result for advertiser 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 even when aggregators do not accept ads. Increased market participation can offset the demand effect, but the result nonetheless informs the active debate on whether aggregators “steal” advertising from content sites.

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. This is an important area for future research. Second, we do not incorporate viewer disutility of advertising in our model. Hence outlet pricing decisions play no direct role in the number of viewers at each site, only in the demand for advertising. This simplified outlet model allows a clear focus on the effects of viewer switching. Finally, we consider only two content sites, which aids in the tractability of our basic model. In general, these assumptions can be relaxed, but doing so contributes little

\[^3\text{Ad tracking technology is considered in some detail in Athey, Calvano & Gans (2010), though the mechanism studied there concerns the potential for tracking to effectively increase advertising capacity, not the tradeoff between placement in low- and high-value contexts.}\]

\[^4\text{Athey, Calvano and Gans (2010) also abstract from viewer disutility of advertising.}\]
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 of the economic literature on media markets and advertising as well as the emerging literature on new media institutions. Section 3 develops the basic model. Section 4 examines the role of aggregation and search on viewers, and section 5 examines these institutions’ effects on advertisers and outlets. Section 6 discusses applications and concludes the paper.

2 Literature

This paper contributes to several themes in the literature of 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 two-sided market models studied 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 (2011) develop richer models that allow 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 (typically called multi-homing in the two-sided market literature) drives many of the results in our model, though the effect arises through the interplay of tastes for variety and search costs rather than the advertising externality.

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. Chiou and Tucker (2010) show that temporary removal of Associated Press content from Google News reduced consumer demand for content from this
The paper also contributes to a growing literature on targeted advertising. 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 (2011) emphasize the role of technology in improving matches between consumer preferences and advertised products. Taylor (2011) considers the role of media quality in holding attention, showing how quality investments can generate exclusive viewership and hence market power over advertisements. Gal-Or et al. (forthcoming) study how heterogeneous advertiser demand for viewers affects product positioning of media firms. Most contributions in this area have been theoretical, but empirically Goldfarb and Tucker (2010) find that better targeted advertising is worth more to advertisers and commands a higher price. Chandra and Kaiser (2010) show heterogeneous consumer valuations in magazines.

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.\(^5\)

The emphasis on broad mental and emotional states emerged in the era of broadcast television, where the sources of targeting and contextual

\(^5\)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.
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.

We now describe our basic model of viewers, advertisers and outlets and derive equilibrium viewership, prices and profits. We then turn to the effects of new media institutions.

3 Model

3.1 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 $U_{ik}(T_{ik})$, where $\alpha_i$ is a parameter uniformly distributed on $[0,1]$. We assume that this utility function has the following properties:

$$\frac{\partial U_{ik}}{\partial T_{ik}} > 0 \quad \frac{\partial^2 U_{ik}}{\partial T_{ik}^2} < 0 \quad \frac{\partial^3 U_{ik}}{\partial T_{ik}^2 \partial \alpha_i} < 0$$ (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 $\alpha_i$. Viewers with high values of $\alpha_i$ 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 $U_{ik}(T_{ik}) = \alpha_i T_{ik}^{1/2}$, 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 $\omega t$.

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 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 $\alpha$: 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

$$\alpha_i (T-t)^{1/2} - \omega t \geq 0$$

$$\alpha_i \geq \frac{\omega t}{(T-t)^{1/2}} = \alpha_0$$

The cutoff between viewers who visit two outlets versus one is

$$2\alpha_i (T/2 - t)^{1/2} - 2\omega t > \alpha_i (T-t)^{1/2} - \omega t$$

$$\alpha_i \left(2(T/2 - t)^{1/2} - (T-t)^{1/2}\right) > \omega t$$

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

Consumers with higher $\alpha$ have more rapidly diminishing utility and will thus go to two outlets, consumers with lower $\alpha$ 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 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 $\beta$ to determine which outlet they visit. One interpretation is that $\beta$ is simply the proportion of viewers in the traditional
(non-digital) media market. If exclusive viewers consume local products first, the exclusive viewership share on each outlet will track the population share across markets.

**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

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

(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 $\beta$ 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:

$$\frac{\partial v_1^e}{\partial v^s} \bigg|_{V_p} = -\beta \quad \frac{\partial v_2^e}{\partial v^s} \bigg|_{V_p} = -(1 - \beta)$$

(3)

### 3.2 Advertisers

There are $A$ advertisers who seek to place advertisements in front of viewers. Advertisers are horizontally differentiated, characterized by their position $\theta_j$ 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 page or a lipstick maker at a fashion 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 earn $\sigma$ 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 $p_k(v)$, where $v = (v_1^e, v_2^e, v^s)$ is a vector describing the viewer outcome. Then the payoff to an advertiser of type $\theta_j$ which advertises only on outlet 1 is

$$R_1(\theta_j, v) = (\sigma - \theta_j)v_1 - p_1(v)$$

(4)

The payoff to an advertiser of type $\theta_j$ which advertises only on outlet 2 is

$$R_2(\theta_j, v) = (\sigma - (1 - \theta_j))v_2 - p_2(v)$$

(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.\footnote{Following Ambrus and Reisinger (2006), the baseline value of an impression $\sigma$ 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 $\rho$ of the viewer population. Viewers in the Ambrus and Reisinger model ignore ads with probability $\epsilon$, 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.} The payoff to multi-homing for an advertiser is

$$R_{12}(\theta_j, v) = (\sigma - \theta_j)v_1^e + (\sigma - (1 - \theta_j))v_2^e + (\sigma + \gamma \sigma - \theta_j - (1 - \theta_j))v^s - p_1(v) - p_2(v)$$
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 adjacent to a recipe than when she views the ad on a fashion page. We will return to this point when we discuss equilibrium prices and welfare.

Given these payoffs, the conditions for advertiser participation are

$$R_1 \geq 0 \quad R_2 \geq 0 \quad (6)$$

and the conditions for multi-homing versus single-homing are

$$R_{12} > R_1 \quad R_{12} > R_2 \quad (7)$$

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

$$(\sigma - (1 - \theta_j))v_2^e + (\gamma \sigma - (1 - \theta_j))v^s > p_2(v)$$

$$\sigma v_2^e + \gamma \sigma v^s - p_2(v) > (1 - \theta_j)(v_2^e + v^s)$$

$$(1 - \theta_j) < \frac{\sigma v_2^e + \gamma \sigma v^s - p_2(v)}{v_2^e + v^s}$$

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

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

$$(\sigma - \theta_j)v_1^e + (\gamma \sigma - \theta_j)v^s > p_1(v)$$

$$\sigma v_1^e + \gamma \sigma v^s - p_1(v) > \theta_j(v_1^e + v^s)$$

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

12
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 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.

\[ A_1 = \frac{\sigma v_1^e + \gamma \sigma v^s - p_1(v)}{v_1^e + v^s} \]  
\[ A_2 = \frac{\sigma v_2^e + \gamma \sigma v^s - p_2(v)}{v_2^e + v^s} \]

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

\[ A_1 = \frac{\sigma v_1^e + \gamma \sigma v^s - p_1(v)}{v_1^e + v^s} \]  
while demand on outlet 2 is

\[ A_2 = \frac{\sigma v_2^e + \gamma \sigma v^s - p_2(v)}{v_2^e + v^s} \]  

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 \( k \).
3.4 Equilibrium

The outlets choose price $p_1$ and $p_2$ to maximize

$$\Pi_1 = A\bar{\vartheta}p_1(v)$$  \hspace{1cm} (10)$$

and

$$\Pi_2 = A(1 - \vartheta)p_2(v)$$  \hspace{1cm} (11)$$

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

$$\frac{d\Pi_1}{dp_1} = A\bar{\vartheta} + Ap_1(v)\frac{d\bar{\vartheta}}{dp_1} = 0$$ \hspace{1cm} (12)$$

$$\frac{d\Pi_2}{dp_2} = A(1 - \vartheta)p_2(v) - Ap_2\frac{d\vartheta}{dp_2} = 0$$ \hspace{1cm} (13)$$

Solving gives:

$$p_1^*(v) = \frac{\sigma v_1^e + \gamma \sigma v^s}{2}$$ \hspace{1cm} (14)$$

$$p_2^*(v) = \frac{\sigma v_2^e + \gamma \sigma v^s}{2}$$ \hspace{1cm} (15)$$

Prices depend on the number of exclusive and switching viewers, where the value of switchers depends on $\gamma$, 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:

$$\bar{\vartheta}^* = \frac{(1 - \sigma)v_2^e + (1 - \gamma \sigma)v^s}{2(v_2^e + v^s)}$$ \hspace{1cm} (16)$$

and

$$\vartheta^* = \frac{\sigma v_1^e + \gamma \sigma v^s}{2(v_1^e + v^s)}$$ \hspace{1cm} (17)$$

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

**Case 1:** All advertisers multi home.

$$\bar{\vartheta}^* \geq 1 \quad \vartheta^* \leq 0$$
**Case 2:** Some advertisers single home, others multi home.

\[
\frac{1}{2} \leq \theta^* < 1 \quad 0 < \theta^* \leq \frac{1}{2}
\]

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

\[
0 \leq \theta^* \leq \frac{1}{2} \quad \frac{1}{2} \leq \theta^* \leq 1
\]

**Case 4:** No advertising.

\[
\bar{\theta}^* < 0 \quad \theta^* > 1
\]

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 (2011). 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:

\[
\Pi_1^*(v) = A\theta p_1^*(v) = \frac{A}{4} \left( \sigma v_1^e + \gamma \sigma v_1^s \right)^2 \left( v_1^e + v_1^s \right)
\]  

(18)

and

\[
\Pi_2^*(v) = A\theta p_2^*(v) = \frac{A}{4} \left( \sigma v_2^e + \gamma \sigma v_2^s \right)^2 \left( v_2^e + v_2^s \right)
\]

(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

\[
R_1^*(\theta_j, v) = (\sigma - \theta_j)(v_1^e + v_1^s) - p_1^*(v)
\]

(20)
\[ R^*_2(\theta_j, v) = (\sigma - (1 - \theta_j))(v^e_2 + v^s) - p^*_2(v) \]  

For multi-homing advertisers, the profit expression becomes:

\[ R^*_{12}(\theta_j, v) = (\sigma - \theta_j) v^e_1 + (\sigma - (1 - \theta_j)) v^e_2 + (\sigma + \gamma \sigma - 1) v^s - p^*_1(v) - p^*_2(v) \]  

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 \( \theta \) moves from 0 to \( \theta \) and advertisers on site two see profits decrease as \( \theta \) moves from 1 to \( \theta \). 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 \( \theta \) 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 2. From the figure, it is clear that advertiser profits depend on the $\theta$ cutoffs, which in turn depend on the equilibrium share of exclusive viewers and switchers.

Fig. 2: Equilibrium Advertiser Profits

The remainder of this section presents comparative static effects of exclusive and switching viewers on the advertising market. These results apply directly to the study of new media institutions covered in sections 4 and 5. We begin our comparative static analysis by looking at effects on prices:

Lemma 2: An increase in the number of exclusive viewers increases an outlet’s optimal advertising price. An increase in the number of switching viewers (which implies a decrease in the number of exclusive viewers) increases an outlet’s optimal advertising price if repeat impressions are worth
more than the outlet’s initial share of exclusive viewers.

\[
\frac{\partial p_1^*}{\partial v_1^e} = \frac{\sigma}{2} \quad \frac{\partial p_2^*}{\partial v_2^e} = \frac{\sigma}{2}
\]  

\[
\left. \frac{dp_1^*}{dv^s} \right|_{V_p} = \frac{\sigma}{2} (\gamma - \beta) \quad \left. \frac{dp_2^*}{dv^s} \right|_{V_p} = \frac{\sigma}{2} (\gamma - (1 - \beta))
\]  

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.

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.

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

\[
\frac{\partial \theta^*}{\partial v_1^e} = \frac{(1 - \gamma)\sigma v^s}{2(v_1^e + v^s)^2} > 0 \quad \frac{\partial \theta^*}{\partial v_2^e} = \frac{(\gamma - 1)\sigma v^s}{2(v_2^e + v^s)^2} < 0
\]

\[
\frac{\partial \theta^*}{\partial v_s} = \frac{(\gamma - 1)\sigma v_1^e}{2(v_1^e + v^s)^2} < 0 \quad \frac{\partial \theta^*}{\partial v_s} = \frac{(1 - \gamma)\sigma v_2^e}{2(v_2^e + v^s)^2} > 0
\]

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

A few comments on \(\gamma\) are warranted. When \(\gamma\) is equal to one, repeat impressions earn advertisers the same baseline value \(\sigma\) 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 \(\sigma\) 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

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

\[
\frac{d\theta^*}{dv^s} \bigg|_{V_p} < 0 \quad \frac{d\theta^*}{dv^s} \bigg|_{V_p} > 0
\]  

(25)

*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. Ad-
vertisers 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, in-
creases single-homing advertiser profits for advertisers near the endpoints.

\[
\frac{dR^*_1(\theta_j, v)}{dv^s} \bigg|_{V_p} = (\sigma - \theta_j)(1 - \beta) - \frac{\sigma}{2}(\gamma - \beta) \\
\frac{dR^*_2(\theta_j, v)}{dv^s} \bigg|_{V_p} = (\sigma - (1 - \theta_j))(1 - (1 - \beta)) - \frac{\sigma}{2}(\gamma - (1 - \beta))
\]

(26)  

(27)

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 \( \theta_j \) 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 unambiguously rise with more viewer switching:
Lemma 5: Assuming to market is covered, multi-homing advertiser profits rise with viewer switching.

\[
\frac{dR^*_1(\theta_j, v)}{dv^s} \bigg|_{V_{\beta}} = [\theta_j \beta + (1 - \theta_j)(1 - \beta) - 1] + \gamma \sigma - \frac{\sigma}{2}(\gamma - 1) > 0 \quad (28)
\]

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 3 for the symmetric case of \( \beta = \frac{1}{2} \).

Fig. 3: Advertiser Profits with Increased Viewer Switching

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

\[
\Pi^*_1(v) = A \tilde{\theta} p^*_1(v) = \frac{A}{4} \frac{\sigma(v^e + \gamma v^s)^2}{v^e + v^s} \quad (29)
\]

Proposition 2: An increase in the number of exclusive viewers on an outlet increases that outlet’s profits. An increase in the number of switching viewers (with the corresponding decrease in the number of exclusive viewers) increases an outlet’s profit if and only if the outlet has a small enough initial share of exclusive viewers \( \beta \) and if the value of second impressions \( \gamma \) is high enough.

\[
\frac{\partial \Pi^*_1}{\partial v^e_1} = \frac{A \sigma v^e_1 + \gamma v^s}{4} \frac{v^e_1 + v^s}{v^e_1 + v^s} \left(2 - \frac{v^e_1 + \gamma v^s}{v^e_1 + v^s}\right)
\]
\[
\frac{\partial \Pi_2}{\partial v_2} = \frac{A \sigma}{4} \frac{v_2 + v^s}{v_2 + v^s} \left( 2 - \frac{v_2 + v^s}{v_2 + v^s} \right)
\]
\[
\frac{\partial \Pi_1}{\partial v^s} = \frac{A \sigma}{4} \frac{v^s + v^s}{v^s + v^s} \left( 2 \gamma - \frac{v^s + v^s}{v^s + v^s} \right)
\]
\[
\frac{\partial \Pi_2}{\partial v^s} = \frac{A \sigma}{4} \frac{v_2 + v^s}{v_2 + v^s} \left( 2 - \frac{v_2 + v^s}{v_2 + v^s} \right)
\]
\[
\frac{d\Pi_1(v)}{dv^s} \bigg|_{V_p} = \frac{A \sigma}{4} \frac{v^s + v^s}{v^s + v^s} \left( 2(\gamma - \beta) - \left( \frac{v^s + v^s}{v^s + v^s} \right) (1 - \beta) \right) \quad (30)
\]
\[
\frac{d\Pi_2(v)}{dv^s} \bigg|_{V_p} = \frac{A \sigma}{4} \frac{v_2 + v^s}{v_2 + v^s} \left( 2(\gamma - \beta) - \left( \frac{v_2 + v^s}{v_2 + v^s} \right) (1 - \beta) \right) \quad (31)
\]

4 Search, Aggregators, and Viewers

Now that we have outlined the base model, we ask how the outcomes are affected by changes in search and aggregators. In particular, we stress that there is a difference between general improvements to search for content and the addition of a content aggregator. This depends on the way viewers choose whether to view one or two outlets.

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 time cost of finding new content. In our model, this can be seen as a reduction in parameter \( t \), which both reduces the disutility of search \( \omega t \) and increases the remaining time that can be spent viewing an outlet \( U_{ik}(T_{ik} - t) \).

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 model, viewers incur time 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 time 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 $p_A$.

4.1 Search and Viewers

Suppose there were an improvement in search technology that lowered $t$. This impacts any viewer, including nonparticipants, exclusive viewers, and switchers. It could potentially cause any of these to change their behavior. In terms of the viewer model we presented in Section 3, a change in $t$ will impact all of the cutoffs between viewer $\alpha$ types.

Lemma 6: Lower search costs decrease the cutoff between exclusive viewers and switchers. Thus the number of switching viewers increases.

$$-\frac{\partial \hat{\alpha}}{\partial t} = -\hat{\alpha} \left( \frac{1}{t} - \frac{\left[ \frac{1}{2(T/2-t)^{1/2}} - \frac{1}{2(T-t)^{1/2}} \right]}{2(T/2 - t)^{1/2} - (T-t)^{1/2}} \right) < 0 \Rightarrow \frac{\partial v_s}{\partial t} > 0$$

Proof: The term in square brackets is positive because the denominator of the first fraction is smaller than the denominator of the second fraction. All other terms are positive by inspection. ■

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.

Similar logic applies to the question of participation. Some viewers will find it worthwhile to incur the search cost for the first time when $t$ falls.

Lemma 7: Lower search costs decrease the cutoff between nonparticipating and exclusive viewers. Thus total participating viewers increase.

$$-\frac{\partial \alpha_0}{\partial t} = -\omega \frac{(T - t/2)}{(T - t)^{3/2}} = -\alpha_0 \left( \frac{1}{t} + \frac{1}{2(T-t)} \right) < 0 \Rightarrow \frac{\partial v_k}{\partial t} > 0$$
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 8:** Lower search costs decrease cutoff $\hat{\alpha}$ by more than cutoff $\alpha_0$. Thus, exclusive viewers fall.

$$\frac{-\partial \hat{\alpha}}{\partial t} < -\frac{\partial \alpha_0}{\partial t} \Rightarrow \frac{\partial v^e_k}{\partial t} < 0$$

**Proof:** Compare the expressions in Lemmas 6 and 7. By construction, $\hat{\alpha} > \alpha_0$. Also, both terms in parentheses contain the term $1/t$. It remains to show that:

$$\frac{1}{(T/2-t)^{1/2}} - \frac{1}{2(T-t)^{1/2}} > \frac{1}{2(T-t)}$$

The above simplifies as follows:

$$\frac{2(T-t)^{1/2}}{(T/2-t)^{1/2}} - \frac{2(T-t)^{1/2}}{2(T-t)^{1/2}} > \frac{2(T/2-t)^{1/2} - (T-t)^{1/2}}{(T-t)^{1/2}} \frac{2(T-t)^{1/2}}{(T/2-t)^{1/2}}$$

$$\frac{2(T-t)^{1/2}}{(T/2-t)^{1/2}} > \frac{2(T/2-t)^{1/2}}{(T-t)^{1/2}}$$

$$2(T-t) > 2(T/2-t)$$

which is true for any positive $T$. Then each term in $-\frac{\partial \hat{\alpha}}{\partial t}$ is larger in absolute value than the corresponding term in $-\frac{\partial \alpha_0}{\partial t}$. ■

This participation effect of search technology can be defined more precisely:

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

\[
\eta = \frac{\partial \hat{\alpha}}{\partial t} - \frac{\partial \hat{\alpha}_0}{\partial t} < 1 \tag{32}
\]

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 \(\eta\) to write the change in exclusive viewers of each outlet as:

\[-\frac{\partial v^e_1}{\partial t} = -\eta \beta \frac{\partial \hat{\alpha}}{\partial t} V \quad -\frac{\partial v^e_2}{\partial t} = -\eta (1 - \beta) \frac{\partial \hat{\alpha}}{\partial t} V\]

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 \(\eta\).

4.2 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

\[
\begin{align*}
\max \quad & \begin{cases}
U_{i1}(T - t) - \omega t \\
U_{i2}(T - t) - \omega t \\
U_{i1} \left( \frac{T}{2} - t \right) + U_{i2} \left( \frac{T}{2} - t \right) - 2\omega t \\
U_{i1} \left( \frac{T}{2} - \frac{t}{2} \right) + U_{i2} \left( \frac{T}{2} - \frac{t}{2} \right) - \omega t - p_A
\end{cases} \\
& \text{visit outlet 1 only} \\
& \text{visit outlet 2 only} \\
& \text{visit both outlets directly} \\
& \text{use aggregator}
\end{align*}
\]
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. There is no \textit{a priori} reason why this third cutoff should 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.

We discuss this aggregator effect on each of the three previous types of viewers: switchers, exclusive viewers, and nonparticipants.

4.2.1 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

$$U_{i1} \left( \frac{T}{2} - \frac{t}{2} \right) + U_{i2} \left( \frac{T}{2} - \frac{t}{2} \right) - \omega t - p_A > U_{i1} \left( \frac{T}{2} - t \right) + U_{i2} \left( \frac{T}{2} - t \right) - 2\omega t$$

$$2\alpha \left( \frac{T-t}{2} \right)^{1/2} - \omega t - p_A > 2\alpha \left( \frac{T}{2} - t \right)^{1/2} - 2\omega t$$

$$\sqrt{2}\alpha (T - t)^{1/2} - \sqrt{2}\alpha (T - 2t)^{1/2} > p_A - \omega t$$

$$\alpha > \frac{p - \omega t}{\sqrt{2(T-t)^{1/2} - \sqrt{2(T-2t)^{1/2}}}} = \tilde{\alpha}$$

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.

4.2.2 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

$$U_{i1} \left( \frac{T}{2} - \frac{t}{2} \right) + U_{i2} \left( \frac{T}{2} - \frac{t}{2} \right) - \omega t - p_A > U_{ij}(T - t) - \omega t$$

$$2\alpha \left( \frac{T-t}{2} \right)^{1/2} - \omega t - p_A > \alpha(T - t)^{1/2} - \omega t$$

$$(\sqrt{2} - 1)\alpha(T - t)^{1/2} > p_A$$

$$\alpha > \frac{1}{\sqrt{2-1}} \frac{p_A}{(T-t)^{1/2}} = \hat{\alpha}_A$$

This expression is independent of $\omega$, 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.

### 4.2.3 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

$$U_{i1} \left( \frac{T}{2} - \frac{t}{2} \right) + U_{i2} \left( \frac{T}{2} - \frac{t}{2} \right) - \omega t - p_A > 0$$

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

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

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

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

### 4.2.4 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:

\[
\begin{align*}
    v_A^s & \geq v^s & v_{jA}^e & \leq v_j^e & v_{1A} & \geq v_j & j = 1, 2
\end{align*}
\]

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.

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 that where \( \alpha_0 < \bar{\alpha} < \hat{\alpha} \), and we will assume this for the remainder of the paper. 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.

### 4.3 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 \( \bar{\alpha} \) cutoff, that is, those with greatest taste for variety.

Comparing whether an aggregator or a search improvement causes larger consumer welfare gains is complex. A definitive answer requires more structure on the utility function and specific assumptions about the changes in the parameters. However, we can gain some insight without these measures.
Suppose there were a change in search costs from $t$ to $t'$ that reduced the
cutoff between switchers and exclusives from $\hat{\alpha}$ to $\hat{\alpha}'$. Suppose we compare
this to the introduction of a hypothetical aggregator that has an aggregator
cutoff $\tilde{\alpha} = \hat{\alpha}'$.

We know that for the viewer with $\alpha = \hat{\alpha}'$, the change in utility is
identical for either the search improvement or the aggregator, because by
definition this consumer is indifferent between (i) switching with the new
search technology versus remaining exclusive and (ii) using the new aggre-
gator versus remaining exclusive.

For all viewers with $\alpha < \hat{\alpha}'$, the improved search causes a welfare gain
because their search costs fall. But the addition of the aggregator does
nothing for these viewers since they choose not to use it. Thus, for lower-$\alpha$
viewers, search improvements are clearly better than an aggregator.

For viewers with $\alpha > \hat{\alpha}'$, the situation is more complicated. We know
these viewers prefer using the aggregator to using search technology $t$, but
we do not know whether they prefer it to search technology $t'$. Thus, some
of these viewers may still prefer better search to an aggregator. However, for
most utility functions and for high enough $\alpha$, there will be some consumers
who do prefer using the aggregator to the improved search technology. They will see welfare gains.

Thus, we can definitely say that improved search benefits low-$\alpha$ viewers
more than an aggregator. And we can say that, in general, an aggregator
benefits high-$\alpha$ viewers more than search improvements.

5 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, using the results we derived in Section 3.

We saw that both search and aggregators result in a change in the num-
ber of switching viewers, although this change depends on the parameters,
and it may not be equal for the two cases. To make a more even compar-
ison, consider a change in the aggregator price that increases the number
of switching viewers by $\delta$. 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 $\delta$. 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.

Now we can use the results from Section 3 to compare aggregators to search. The effect on advertiser prices is shown in the following lemma.

**Lemma 9:** If switchers increase by $\delta$, an aggregator changes the advertising price of outlet 1 changes according to

$$dp_{1}^{a} = \frac{\partial p_{1}^{*}}{\partial v^{a}} \delta + \frac{\partial p_{1}^{*}}{\partial v^{e}} (-\beta \delta) = \frac{1}{2} \sigma (-\beta + \gamma) \delta$$

while a search improvement changes it according to

$$dp_{1}^{s} = \frac{\partial p_{1}^{*}}{\partial v^{s}} \delta + \frac{\partial p_{1}^{*}}{\partial v^{e}} (-\eta \beta \delta) = \frac{1}{2} \sigma (-\eta \beta + \gamma) \delta$$

As we saw in Lemma 2, the advertising price could rise or fall, but it will always be more positive with search technology because of the participation effect captured by $\eta < 1$.

Returning to Proposition 1, we know that an increase in viewer switching will shift the $\theta$ cutoffs inward. More advertisers will single-home rather than multi-home. The cutoffs also shift inward when the number of exclusive viewers decreases. Since both of these effects occur together, the direction of the effect is clear: more viewer switching will tend to decrease advertiser multi-homing. This is another example of the result that more multi-homing on one side of the market causes more single-homing on the other side.

Now putting the two together, we can see the effect of an increase in switching on content outlet profits:

**Proposition 3:** If switchers increase by $\delta$, an aggregator changes the profit
of outlet 1 according to
\[
\frac{\partial \Pi^*_1}{\partial v^s} \delta + \frac{\partial \Pi^*_1}{\partial v^e_1} (-\beta \delta) = A \left( \frac{\partial \tilde{\theta}^*}{\partial v^s} \delta + \frac{\partial \tilde{\theta}^*}{\partial v^e_1} (-\beta \delta) \right) p^*_1 + A \tilde{v}^* dp^*_a
\] (35)

while a search improvement changes it according to
\[
\frac{\partial \Pi^*_1}{\partial v^s} \delta + \frac{\partial \Pi^*_1}{\partial v^e_1} (-\eta \beta \delta) = A \left( \frac{\partial \tilde{\theta}^*}{\partial v^s} \delta + \frac{\partial \tilde{\theta}^*}{\partial v^e_1} (-\eta \beta \delta) \right) p^*_1 + A \tilde{v}^* dp^*_a
\] (36)

Again we see that this can rise or fall, but it will always be more positive with search technology since \( \eta < 1 \).

6 Discussion and Conclusions

In this section we focus on key results from our model and insights relevant to future work. First, search technology captured by \( t \) is crucial to consumption in digital media markets. When consumers make discrete choices over platforms as in traditional two-sided market models, ad nuisance drives consumption. But 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, they are also important in determining the advertising equilibrium.

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 5 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 research.

References


