Intent and Interest: The Attention Economy of Search and Web Advertisement*

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Abstract

Two types of online advertising, search and display, use strikingly different techniques to target and attract consumers. Despite these differences, both compete for a single scarce resource: user attention. We analyze the competition between search engines (SEs) and content-based websites (CBWs) to transform attention into revenue.

We show that, since search results and web content are often complementary goods for a user, SEs and CBWs face two distinct coordination problems when designing their advertising strategies. The first is the classic problem of double marginalization among sellers of complements. The second potential problem is new: the need to efficiently allocated demands to a given user for her attention.

Because of this second issue, the market for user attention exhibits surprising behavior when competition increases. In particular, heightened competition among a given type of site (SEs or CBWs) may cause social welfare to decrease by giving the other type of site incentive to make more inefficient demands for the users attention.

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1 Introduction

In the recent swell of focus on the economics of search engines, one aspect that has, to the best of our knowledge, gone unstudied is the fact that Internet users surf quickly from search engines to other sites that also advertise. Since both search engines and other websites contain advertisement, and since users have limited attention, one might expect the advertisement appearing on one type of sight to influence the fortunes of the other type. In this paper, we examine what seems to us a particularly important form of interplay between search engines and other websites.

We focus on two main points. First, we observe that, while both search engines and other websites advertise, there are important differences in the methods that they use. The vast majority of search engine advertising is subtle and text-based. Moreover, the determination of which ads are shown is made on the basis of "keyword auctions" that the major search engines invite advertisers to participate in, and are charged on a per-click basis. In contrast, the most prominent – and profitable – advertising on non-search sites is "display advertising". This method features ever-flashier banners, animations and even sounds that pop out at the user from somewhere on the page. This form of advertisement is sold through a rather large number of different channels, ranging from direct negotiations between individual websites and advertisers to matching via third-party ad networks. Display advertising is typically sold on a per impression basis.

Beyond these differences, a crucial distinction between search and non-search advertising is the type of need it typically attempts to fulfill for the user. Since users type queries into search engines, they frequently give a "real time" indication something they might be hoping to purchase. As a result, search engines have outstanding access to what we call user "intent". On the other hand, non-search websites typically do not receive such timely information. They do, however, often know something about the broader "interests" of their visitors. For instance, a visitor to a site about outdoor photography is likely more prone than the average person to be a potential buyer of zoom lenses.

Second, we claim that, often, search engines and other websites act as perfect (or near perfect) complements in the utility function of the user. This stems from two observations. One is the idea that websites can be rather difficult to locate without a search engine, and the other is that search engines would be rather uninteresting without other websites. As a result, while it is certainly not always so simple, we consider such a complementary relationship to provide a useful approximation.

These two points – differing advertising technologies between search and non-search sites, and complementarity for the user – lead to two interesting economic problems. One of these problems in the well-known issue of double marginalization, whereby decentralized providers of a good exact a toll on consumers that is sub-optimally high. The second problem is, to the best of our knowledge, new. We refer to it as "deadweight distraction", and it results from the fact that two types of advertisers each make attention demands on users in a disorganized way. In section 2, we describe a general model of search and web advertisement in which these issues arise. In section 3, we consider the case with just one of each type of site. In section 4, we extend the analysis to include competing websites.

2 A Model of Search and Web Advertisement

The model features three types of agents: "search engines" (SEs), "content-based websites" (CBWs) and "users". In the game, both SEs and CBWs set advertising levels and then users decide which of these sites to visit. A central assumption of our model is that, for users, search engines and content sites are complements. The idea motivating this assumption is that a search engine is often necessary for identifying and locating *other* sites that are of interest, but that, *in and of itself*, it offers users very little excitement.

A second key assumption is that SEs and CBWs have differing technologies for turning user "attention" into revenue. This follows from the fact that, when people use a search engine, they typically type in a query that reveals their "current intent", which the SE can use to determine which ads to show. CBWs, meanwhile, typically do not receive such a precise user-generated signal. However, from the mere fact that a user is visiting a particular page, they can infer a good deal about a user's more general "interests" and can catch users' attention by displaying related advertisements.

User Preferences. The general model allows for there to be M SEs, indexed by k, and N CBWs, indexed by l, where M and N are positive integers. There are is a continuum of users of mass one. We assume that user i's utility is given by u_i, where

$$u_i = \begin{cases} v^i_{kl} - d_s(a_k) - d_w(a_l), & \text{if visits SE } k \text{ and CBW } l \\ -d_s(a_k), & \text{if visits only SE } k \\ 0, & \text{if visits neither.} \end{cases}$$

Here, v^i_{kl} denotes the benefit or enjoyment user i derives from the combined experience of using search engine k and viewing the content on site l. The terms a_k and a_l denote, respectively, the "advertising levels" chosen by search engine k and content site l. The functions $d_s(\cdot)$ and $d_w(\cdot)$ represent the "distraction", "attention demands" or "nuisance" caused by advertising. The former quantifies the amount of distraction caused by a given level of "search advertising", and the latter by a given level of "web advertising". Except where otherwise stated, we assume that it is unfeasible for sites to charge users money instead of, or in addition to showing advertisements.

SE and CBW Profits. In speaking of a site's "advertising level", we mean the maximum amount of revenue generated per user, for a given level of distraction. Thus, we can write search engine k's profits, π_k, as

$$\pi^k_s = a^k_s \times [\text{No. of visitors to SE } k],$$

and content site l's profits, π_l, as

$$\pi^l_w = a^l_w \times [\text{No. of visitors to CBW } l].$$

Clearly, the number of visitors to each site arises endogenously and may be a function of all sites' strategies.

Timing. The game proceeds in the following order.

1. All SEs and CBWs simultaneously set their advertising levels.
2. Users select a search engine or do nothing.
3. Users who selected a search engine may select a website or do nothing.

Note that we assume users observe the advertising levels chosen in the first stage. Also note that search engines play no active role in determining which website a user selects – for instance, we do not allow for an SE to "hide" a given CBW or to display one more prominently than others. This simplification is made here in order to focus purely on the choice of advertising levels and is the subject of an extension to be added.

In the following sections, we consider several special cases of this model. In the next section, we examine the case where there is just one search engine and one website. Later, we look at various forms of intra-sector competition.

3 One SE, One CBW; Two Problems

This section examines several of the simplest cases of the more general model. These cases are designed to illustrate, in a clear way, the two fundamental issues of coordination that arise, more generally, between search engines and content sites. The first issue is the classic problem of double marginalization, and the second issue is the phenomenon more novel to this economic setting – and to this model, which we term "deadweight distraction".

To understand these two issues, let us first look at a very special situation in which neither is present. Assume that users all have the same valuation for the combined experience of searching and visiting the content site. Moreover, assume that, instead of advertising, both the SE and the CBW charge money to users in exchange for access. Formally, this translates to the case where, when a user visits both sites, she receives a payoff of $u_i = v - a_s - a_w$, the SE makes profits $\pi_s = a_s$ and the CBW makes profits $\pi_w = a_w$. (We now index the lone SE by s and the lone CBW by w.)

Let a_s^* and a_w^* denote the sites' (pure) equilibrium strategies. In any of the relevant subgame perfect equilibria[1] of this game, $a_s^* + a_w^* = v$, and all users visit both sites. From the standpoint of the "industry" as a whole – i.e. the SE and the CBW – this is the best possible outcome, as they extract all of the rent from the user. Furthermore, under this setup, the particular division of profits going to the SE and the CBW has no bearing on the industry total.

We now introduce the problem of deadweight distraction. Assume, in contrast to the last example, that the SE and the CBW can make money only from advertising. Continue to assume that all users have the same valuation for the combined experience. In this scenario, when a user visits both sites, she receives a payoff of $u_i = v - d_s(a_s) - d_w(a_w)$. For simplicity, assume that, for $j = s, w$, $d_j(\cdot)$ is twice-differentiable, satisfying the following properties: $d_j(0) = 0$, $d_j'(0) = 0$, $d'' > 0$ and $d'(\infty) = \infty$. For games in this class, subgame perfect equilibria satisfy

$$d_s(a_s^*) + d_w(a_w^*) = v. \tag{1}$$

As before, the sites' advertising strategies leave users with no rent. In contrast to the previous example, however, the outcomes consistent with equilibrium typically *do not* maximize industry profits. A second necessary condition for these to be maximized, in addition to (1), is that a_s and a_w satisfy

$$d_s'(a_s) = d_w'(a_w), \tag{2}$$

which generically does not hold in equilibrium.

This failure of (2) to hold in equilibria of such games is what we refer to as "deadweight distraction". The intuition behind this failure is the following. The SE and the CBW each has its own technology transforming attention into revenue. Beginning from an arbitrary level of advertising by both sites, sometimes the SE may be able to increase its revenue per user, incrementally, while causing less distraction to users than would be caused by an equivalent increase made by the CBW. Other times, the CBW may

[1] There are also subgame perfect equilibria where $a_s^* > v$ and $a_w^* > v$, and the user does not visit the sites. For our purposes, these require no attention.

be in a position to increase its advertising revenue more efficiently than the SE.

In any outcome where such a disparity exists, the SE and the CBW do not maximize their total potential profits. Seen another way, they could make the same joint profits while requiring users to suffer less distraction. Fundamentally, this coordination problem is one of *allocation*; for a given amount of user attention, the two sites fail optimally organize the way in which they demand it.

3.1 Heterogenous Users

We now consider a generalization of the previous example, in which users have personalized valuations for the experience of searching and visiting the content site. Specifically, assume that $v_i \sim (\underline{v}, \bar{v})$, characterized by cdf, $F(\cdot)$, and pdf, $f(\cdot)$ and that this distribution leads to an interior solution. These assumptions imply the result given in proposition 1.

Proposition 1. *With one SE, one CBW and heterogenous users, equilibrium advertising levels a_s^* and a_w^* must solve*

$$a_s^* + a_w^* = \frac{1-F}{f}\left(\frac{1}{d_s'} + \frac{1}{d_w'}\right). \tag{3}$$

Proof. The result in (3) follows from the maximization of each site's profits, given by

$$\max_{a_j} \{a_j \left[1 - F(d_j(a_j) + d_k(a_k))\right]\}$$

where $j = s, w$ and $k \neq j$. □

The expression in (3) reflects the two coordination problems we have discussed. Focusing first on the problem of double marginalization, note that, individually, in equilibrium, each site j chooses a_j^* so as to satisfy $a_j^* = (1-F)/fd_j'$. As each site sets its advertising level to equate its infra-marginal gain to its marginal loss, it ignores the negative externality it imposes on the other. The result is an overall advertising level that is inefficiently high. Second, as in the previous examples, there is deadweight distraction, stemming from the fact that marginal rates of distraction with respect to advertising, d'_s and d'_w are not equal.

These two issues can be understood more clearly when one compares the above equilibrium property with the total profit-maximizing and the social welfare-maximizing outcomes. These are given in proposition 2.

Proposition 2. *With one SE, one CBW and heterogenous users, joint profit-maximizing advertising levels, a_s^π and a_w^π, must solve*

$$a_s^\pi + a_w^\pi = \frac{\frac{1-F}{f}\left(\frac{1}{d'_s} + \frac{1}{d'_w}\right)}{2} \tag{4}$$

and

$$d'_s(a_s^\pi) = d'_w(a_w^\pi). \tag{5}$$

Social welfare-maximizing advertising levels, a_s^o and a_w^o, must solve

$$a_s^o + a_w^o = \frac{\frac{1-F}{f}\left(\frac{1}{d'_s} + \frac{1}{d'_w} - 2\right)}{2} \tag{6}$$

and

$$d'_s(a_s^o) = d'_w(a_w^o). \tag{7}$$

Proof. Equations (4) and (5) can be derived from

$$\max_{a_s, a_w} \left\{(a_s + a_w)\left[1 - F(d_s(a_s) + d_w(a_w))\right]\right\}.$$

The expressions in (6) and (7) are implied by

$$\max_{a_s, a_w}\{(a_s + a_w)\left[1 - F(d_s(a_s) + d_w(a_w))\right] + \int_{d_s(a_s)+d_w(a_w)}^{\bar{v}} (1 - F(x))dx\}.$$

□

Regarding the conditions for total profit-maximization, note that the double marginalization problem is accounted for by the fact that each advertising level, a_j^π, solves $a_j^\pi = (1-F)/fd_j' - a_k^\pi$. Expressed this way, we can interpret each site's advertising as "topping up" the other's just enough to demand the optimal amount of user attention from the industry's perspective. Moreover, since (5) holds, these attention demands are made in the most efficient way possible, given the overall level.

Turning to the social welfare-maximizing advertising levels, note, first, that (6) implies that it is socially optimal for there to be a strictly positive amount of both search and web advertising. This contrasts with the standard intuition saying that a when a good costs nothing to produce, giving it away for free maximizes social welfare. The reason this intuition does not hold stems from the fact that, at very low levels, advertising produces revenue for the sites while causing almost no distraction for users.

Consequently, there is a tradeoff: as advertising increases from zero, attention is efficiently transformed into revenue, but at the same time, some users no longer choose to visit the sites, even though the experience (gross of advertising distraction) would give them positive utility at no cost to society. The expression in (6) represents the solution to this tradeoff.[2] At the same time, as (7) implies, when social welfare is maximized, there is no deadweight distraction.

The overarching lesson of proposition 2 is that the tendency for an SE and a CBW to fail to effectively coordinate both on the *level* and the *allocation* of attention demands harms both total profits and users' experience. These results, do not, however, give such clear intuition regarding the relationship of these coordination problems to one another. In particular, one might be inclined to ask whether settings in which there is some competition among either SEs or CBWs is likely to be better or worse from the standpoint of total profits and social welfare. To address this issue, in the next section we consider a situation in which there are two, competing CBWs.

[2]Note that, in the case discussed earlier where the sites can charge users money and thus $d_j(a_j) = a_j$, there are no welfare gains brought about by a positive price, and we have $a_j^o = 0$ for $j = s, w$.

4 Competing Websites

4.1 A Model of Horizontal Differentiation

In this section, we consider a situation in which there is a single search engine, which users can use to locate one of two competing content-based websites. We model the CBWs to be horizontally differentiated, "located" at opposite ends of a Hotelling line of length one, along which users are uniformly distributed. One might imagine these CBWs to be, for instance, two relatively similar news sites, sports sites or entertainment sites, so that both would appear prominently on the SE's results page for a given query.

We continue to index the single SE by s, and we denote the CBWs by 1 and 2. To allow for analytic solutions, we consider the following distraction functions. For search engine advertising, a_s, user distraction is given by $d_s(a_s) = \alpha_s a_s^2$. For advertising on content site $l = 1, 2$, user distraction is given by $d_w(a_l) = \alpha_w a_l^2$. We assume that $\alpha_s > 0$ and $\alpha_w > 0$. Under this setup user i's utility function, u_i, can be written

$$u_i = \begin{cases} v - x_i\tau - \alpha_s a_s^2 - \alpha_w a_1^2, & \text{if visits SE and CBW 1} \\ v - (1 - x_i)\tau - \alpha_s a_s^2 - \alpha_w a_2^2, & \text{if visits SE and CBW 2} \\ -\alpha_s a_s^2, & \text{if visits only SE} \\ 0, & \text{if visits none.} \end{cases}$$

Here, τ is the standard parameter in a Hotelling framework, we which take to represent the degree of differentiation between the two CBWs.

4.2 User Behavior

Recall that, when asked to decide whether to visit the SE, users have observed all of the advertising levels that have been chosen. It is thus straightforward to see that no user i ever visits only the search engine; if she searches, she also chooses to visit the CBW offering a higher payoff. She prefers content site 1 if and only if

$$- x_i\tau - \alpha_w a_1^2 \geq (1 - x_i)\tau - \alpha_w a_2^2$$
$$\Leftrightarrow \qquad x_i \leq \frac{1}{2} + \frac{\alpha_w}{2\tau}(a_2^2 - a_1^2).$$

Moreover, in order for searching and visiting CBW l to be the user i's optimal choice, compared to visiting no sites at all, it must be the case that

$$\frac{v - \alpha_s a_s^2 - \alpha_w a_l^2}{\tau} \geq \begin{cases} x_i, & \text{if } l = 1 \\ 1 - x_i, & \text{if } l = 2. \end{cases}$$

Using this characterization of users' best-replies to a given vector of advertising levels, $\{a_s, a_1, a_2\}$, we write the profit maximization problem facing the sites in the first stage of the game. The problem facing the search engine can be written as

$$\max_{a_s} \begin{cases} a_s, & \text{if } a_s^2 \leq \frac{v - \alpha_w \bar{a_w^2} - \frac{\tau}{2}}{\alpha_s} \\ a_s \times \frac{2}{\tau}(v - \alpha_w \bar{a_w^2} - \alpha_s a_s^2), & \text{if } a_s^2 > \frac{v - \alpha_w \bar{a_w^2} - \frac{\tau}{2}}{\alpha_s} \end{cases},$$

where $\bar{a_w^2} \equiv \frac{a_1^2 + a_2^2}{2}$. Note that when

$$a_s^2 \leq \frac{v - \alpha_w \bar{a_w^2} - \frac{\tau}{2}}{\alpha_s} \tag{8}$$

holds, the market is "covered", and when this is the case, the demand for the SE is equal to the entire mass of users. When (8) does not hold, the market is "uncovered", and the SE's demand is less than one. Moreover, note that while the search engine's profits depend on the average distraction caused by the advertising of the CBWs, the relative shares caused by 1 and 2 are irrelevant from the SE's perspective.

For CBW l, the profit maximization problem is given by

$$\max_{a_l} \begin{cases} a_l \times \left(\frac{1}{2} + \frac{\alpha_w}{2\tau}(a_k^2 - a_l^2)\right), & \text{if } a_l^2 \leq \frac{2v - 2\alpha_s a_s^2 - \tau}{\alpha_w} - a_k^2 \\ a_l \times \frac{v - \alpha_w a_l^2 - \alpha_s a_s^2}{\tau}, & \text{if } a_l^2 > \frac{2v - 2\alpha_s a_s^2 - \tau}{\alpha_w} - a_k^2 \end{cases}, \tag{9}$$

where $k \neq l$. The first inequality, written here in terms of a_l^2, is equivalent to (8), and hence, the market is covered if and only if it is satisfied. It is interesting to note that, for CBWs, when the market is covered, they compete directly only with one another, and the expression for payoffs correspond closely to those arising in standard Hotelling competition. On the other hand, when the market is uncovered, the CBWs do not compete directly with one another but, instead, each compete directly with the SE for user attention.

4.3 Equilibrium Analysis

We are now in a position to compute the sites' best responses as functions of one another's advertising levels. These best-response function are given in lemma 1. Since it is notationally most convenient, we write these in terms of the squares of the advertising levels.

Lemma 1. *In the game with one search engine and two horizontally differentiated content-based websites, the SE's best-response function to the CBWs' advertising is given by*

$$a_s^{2*}(\bar{a_w^2}) = \begin{cases} \frac{v - \alpha_w \bar{a_w^2} - \frac{\tau}{2}}{\alpha_s}, & \text{if } \bar{a_w^2} \leq \frac{v - \frac{3\tau}{4}}{\alpha_w} \\ \frac{v - \alpha_w \bar{a_w^2}}{3\alpha_s}, & \text{if } \bar{a_w^2} > \frac{v - \frac{3\tau}{4}}{\alpha_w} \end{cases} . \tag{10}$$

CBW l's best-response function to the SE and the other CBW, k's advertising is given by

$$a_l^{2*}(a_s^2, a_k^2) = \begin{cases} \frac{1}{3}\left(\frac{\tau}{\alpha_w} + a_k^2\right), & \text{if } \frac{\tau + \alpha_w a_k^2}{v - \alpha_s a_s^2} \leq \frac{3}{2} \\ \frac{2v - 2\alpha_s a_s^2 - \tau}{\alpha_w} - a_k^2, & \text{if } \frac{3}{2} < \frac{\tau + \alpha_w a_k^2}{v - \alpha_s a_s^2} \leq \frac{5}{3} \\ \frac{v - \alpha_s a_s^2}{3\alpha_w}, & \text{if } \frac{\tau + \alpha_w a_k^2}{v - \alpha_s a_s^2} > \frac{5}{3} \end{cases} . \tag{11}$$

Proof. To prove (10), we note that the SE will never choose to satisfy (8) with strict inequality. If it did, it could strictly increase profits by increasing its advertising level by some positive amount while continuing to attract all users. Thus it will choose a_s^{2*} such that

$$a_s^* = \max\left\{\sqrt{\frac{v - \alpha_w \bar{a}_w^2 - \frac{\tau}{2}}{\alpha_s}}, \arg\max_{a_s}\{a_s \frac{2}{\tau}(v - \alpha_w \bar{a}_w^2 - \alpha_s a_s^2\})\right\} \tag{12}$$

Solving the second term in (12) and comparing to the first terms yields (10).

To prove (11), note first that (9) is a continuous function of a_l. Then, define

$$\hat{a}_l \equiv \arg\max_{a_l}\left\{a_l \times \left(\frac{1}{2} + \frac{\alpha_w}{2\tau}(a_k^2 - a_l^2)\right)\right\},$$

$$\tilde{a}_l \equiv \sqrt{\frac{2v - 2\alpha_s a_s^2 - \tau}{\alpha_w} - a_k^2}$$

and

$$\hat{\hat{a}}_l \equiv \arg\max_{a_l}\left\{a_l \times \frac{v - \alpha_w a_l^2 - \alpha_s a_s^2}{\tau}\right\}.$$

By solving for $\hat{a}_l$ and $\hat{\hat{a}}_l$, one can show that whenever $\frac{\tau + \alpha_w a_k^2}{v - \alpha_s a_s^2} \leq \frac{3}{2}$, we have $\hat{a}_l \leq \tilde{a}_l$ and $\hat{\hat{a}}_l < \tilde{a}_l$. Hence, in this case, $\hat{a}_l$ maximizes (9). Whenever $\frac{3}{2} < \frac{\tau + \alpha_w a_k^2}{v - \alpha_s a_s^2} \leq \frac{5}{3}$, we have $\hat{a}_l > \tilde{a}_l$ and $\hat{\hat{a}}_l \leq \tilde{a}_l$. Hence, in this case, $\tilde{a}_l$ maximizes (9). Finally, whenever $\frac{\tau + \alpha_w a_k^2}{v - \alpha_s a_s^2} > \frac{5}{3}$, we have $\hat{a}_l > \tilde{a}_l$ and $\hat{\hat{a}}_l > \tilde{a}_l$. Thus, in this case, $\hat{\hat{a}}_l$ maximizes (9). Using the expressions we have found for $\hat{a}_l$ and $\hat{\hat{a}}_l$, we find (11). □

The expression for the search engine's best response, (10) can be understood as follows. When the average level of distraction caused by CBW advertising is relatively low, the SE will respond by advertising exactly enough so that the market's coverage is binding. In such scenarios, increasing its advertisement by any more would turn off some users, and this lost volume would outweigh the additional revenue per infra-marginal user. On the other hand, when the average distraction from CBWs is higher, it is no longer worth it for the SE to leave the market covered. This is because, in such cases, the to capture enough attention of the users that are most attracted to the two CBWs, the search engine must impose so much distraction on more ambivalent users that they no longer choose to search.

The CBWs' best response function carries similar intuition but is slightly more subtle than that of the SE. Note first that in the domain of the first two regimes of this function, where

$$\frac{\tau + \alpha_w a_k^2}{v - \alpha_s a_s^2} \leq \frac{3}{2}, \tag{13}$$

the CBW will leave the market covered, whereas, when (13) does not hold, it will advertise enough so as to exclude some users from searching and visiting either website. In such a situation, where (13) holds, the overall high level of advertising done by the other CBW and the SE makes it optimal for some users to be inactive. Moreover, in this case, each CBW reacts to the SE's advertising as a strategic substitute, since this competes for the same attention of "captive" users that the CBW is after.

In the intermediate region, where

$$\frac{3}{2} < \frac{\tau + \alpha_w a_k^2}{v - \alpha_s a_s^2} \leq \frac{5}{3}, \tag{14}$$

the CBW chooses to leave the market barely covered – an arbitrarily small increase would exclude some users. Here, both the CBW competes directly with both the SE and the other CBW. This is in contrast with the case where neither (13) nor (14) holds, since in such situations, each CBW's demand is locally unaffected by the SE's advertisement. This arrangement implies that for the two CBWs, advertisement is a strategic complement.

We now characterize the equilibria of this class of games. Proposition 3 describes the equilibria in which the market is uncovered.

Proposition 3. *In the game with one search engine and two horizontally differentiated content-based websites, when the two CBWs are sufficiently differentiated, the market is uncovered and there is a unique equilibrium. Specifically, when $v/\tau < 1$, equilibrium advertising levels are*

$$a_s^* = \sqrt{\frac{v}{4\alpha_s}} \quad \text{and} \quad a_l^* = \sqrt{\frac{v}{4\alpha_s}}.$$

SE profits are $\frac{v}{2\tau}\sqrt{\frac{v}{\alpha_s}}$*, and each CBW's profits are* $\frac{v}{4\tau}\sqrt{\frac{v}{\alpha_w}}$*. Consumer surplus is equal to* $\frac{v^2}{2\tau}$*.*

Proof. To be added. □

- Add discussion of prop. 3
- Add proposition 4 on covered equilibria: show that when market is covered, consumer surplus is *increasing* in τ. Differentiation exacerbates the problem of deadweight distraction.
- Compare equilibria to industry optimum and social optimum

5 Conclusion

To be added.

6 References/Related Work (to be discussed)

- Web and Search:
  Evans (RNE '08), Katona & Sarvary (MS '08), White (WP '08)
- Advertising Platforms:
  Anderson & Coate (RES '05), Choi (IEP '06),
  Crampes, Haritchabalet & Jullien (JIE forthcoming)
- Competition among Complement Producers: Casadesus-Masanell, Nalebuff &Yoffie (WP),
  Cheng & Nahm (RJE '07)