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Paying to remove advertisements

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ABSTRACT

Media firms sometimes allow consumers to pay to remove advertisements from an ad-based product. We formally examine an ad-based monopolist's incentives to introduce this option. When deciding whether or not to introduce the option to pay, the monopolist compares the potential direct revenues from consumers who pay, with the lost advertising revenues resulting from the subsequent ad removal. If the pay alternative is introduced, the media firm increases advertising quantity to make the option to pay more attractive. This outcome hurts consumers but benefits the media firm and the advertisers. Total welfare may increase or decrease. Perhaps surprisingly, more annoying advertisements may lead to an increase in advertising quantity.

1. Introduction

There are many recent examples of firms that allow consumers to pay to remove advertisements from an otherwise advertising-based product. In 2008, for example, Slashdot.org allowed users to pay $5 for 1000 ad-free pages.[1] Gamespot.com offered a monthly subscription at $3.33 that gives the subscriber access to "The GameSpot experience without intrusive ads or commercials."[2] The Walt Disney Company (and many others) offered TV series for purchase through the iTunes store at $1.99 per episode. A free alternative with advertisements has recently been available on their homepage or on television.[3] We7 has offered music downloads with ads attached to the beginning of the songs for free or alternatively, without the ads at a fee.[4] There are also companies such as Ultramercial that have allowed consumers to "pay" for premium content on websites by watching a series of interactive advertisements.[5]

These examples highlight a strategy in which media providers practice second-degree price discrimination by offering two versions of their content that differ in advertising quantity. This strategy is easily implemented by online media firms, since their advertisements are usually

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[1] http://slashdot.org/faq/subscriptions.shtml (accessed December 2008).
[2] http://www.gamespot.com (accessed December 2008).
[3] See http://www.apple.com/itunes/ (accessed December 2008). Some cable television companies also offer subscription services for digital video recorders that can be set to automatically remove advertisements from recorded shows.
[4] See http://www.we7.com (accessed December 2008).
[5] See http://www.ultramercial.com (accessed December 2008).

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separated easily from content. In general, there has been a shift in the distribution costs of content; online media firms now find it easier to distribute multiple versions of their content. That strategy is in stark contrast to traditional print and broadcasting media, where distribution costs are typically higher. Technologies such as streaming digitally compressed video over the Internet, for example, make it easy to charge consumers for ad-free versions of television shows.

But what are the incentives of media firms to introduce the option to pay to remove advertisements? And what are the welfare implications? In this paper, we aim to answer these increasingly important questions. The provision of programming and advertising in the broadcasting industry is subjected to considerable attention from regulators. For example, advertising quantity is regulated in several European countries. As an increasing amount of advertising expenditures moves online, the implications of newly available strategies, such as charging consumers for the removal of advertisements, are likely to become important in policy discussions.

We set up a stylized model of a monopoly media firm entirely financed by advertisements. Consumers are assumed to dislike advertisements, so that in our model the bundling of advertisements with a good reduces the perceived quality of the good ("damages" the good). Using this framework, we study the incentives of the firm to introduce an ad-free version of its product at a positive price. Advertising quantity, and hence the quality of the free advertising-based version, is endogenous. We show that the monopolist will introduce the pay option if the disutility from advertisements experienced by consumers is sufficiently high in relation to advertisers' profit margins from reaching users.

We highlight three results. First, if the option to pay is introduced, there is an increase in advertising quantity. The media firm compares the revenue from paying consumers to the potential advertising revenue that can be earned by connecting those consumers to advertisers. Because the free advertising-based product negatively affects the sales of a paid version without advertisements, it is optimal for the media firm to increase advertising quantity in the free version when the option to pay to remove advertisements is introduced. This result has the empirical implication that observed advertising quantity should be higher if the option to pay to remove advertisements is available.

Second, optimal advertising quantity in the free version may increase if consumers' dislike of advertisements increases. The reason for this result is that increasing advertising quantity is a more effective way of reducing the perceived quality of the free version when consumers' disutility from advertisements is high. Hence, an empirical implication is that advertisements should be more annoying and intrusive if the option to pay to remove ads is present.

Third, we show that introducing the option to pay decreases consumer welfare, while both media firm and advertiser profits increase. Consumer welfare decreases because consumers using the free version see more advertisements, and consumers paying to remove advertisements pay a price to remove advertisements that causes more disutility than the advertisements would have caused had the option to pay not been available.

Our paper is related to the literature on price discrimination in media markets, to the literature on quality segmentation and damaged goods, and to the recent literature on two-sided markets.

We contribute to the literature on price discrimination in media markets by introducing the option to pay to remove advertisements from an otherwise ad-based free product. Previous analyses in the media market literature have focused on welfare issues related to pay-per-view versus free airing of outstanding events (such as boxing matches). Price discrimination is an issue in these cases since the media firm can require consumers to pay to watch the event live and then air it for free a day later. This is the setup of Holden (1993), who concludes that consumers are harmed by the possibility of pay-per-view. Hansen and Kyhl (2001) consider a slightly different setup where the pay-per-view version contains advertisements and no free version is available. They find that consumer welfare is enhanced by a ban on pay-per-view events, but that the overall impact on welfare is ambiguous. A recent addition to the literature is the work of Anderson and Gans (2008), who examine the impact on broadcaster behavior when consumers adopt advertising avoidance technologies.[6] They show that advertising quantity could increase, since the remaining consumers are less averse to advertising. As a result, programming would be tailored to appeal to a broader range of viewers and overall welfare and program quality could decrease. Price discrimination in media markets has also attracted attention in the marketing literature. Prasad et al. (2003) analyze the incentives to price discriminate when consumers are of two given types and a media firm may offer two versions differing in advertising quantity and price. They show that offering two versions (price discrimination) tends to be optimal in most cases.

We contribute to the literature on inter-temporal and product quality segmentation, mainly in relation to the literature on damaged goods.[7] Deneckere and McAfee (1996) examine a firm's incentive to "damage" an already developed product in order to obtain a lower quality version. Chiang and Spatt (1982) study quality reduction by means of bundling wait time and Salop (1977) studies quality reduction by means of bundling search costs with the product. In our setup, quality is reduced by bundling advertisements with the product. "Damaging" goods with advertisements is different from previous studies since it generates a new source of revenues for the firm. This gives the firm an additional incentive to "damage" its goods. Our paper also relates to the vertical product differentiation literature (e.g., Shaked and Sutton, 1982; Greenstein and Ramey, 1998) in that we study the incentives to bring out a higher quality product at a fee in addition to a free, but lower quality, advertising-based product.

[6] See also Wilbur (2008a,b) for empirical results relating to the use of advertising avoidance technologies.

[7] For a good treatment of damaged goods and versioning, see Varian (2001).

Finally, we contribute to the literature on two-sided media markets[8] and to the two-sided market literature in general.[9] In our setup, both the price and the quality of the lower quality version depend on the price for advertising space set on the other side of the market. In a one-sided market, prices are set given the qualities of the different versions. Here, as prices for the versions change, so does the attractiveness of advertising space to advertisers. This, in turn, affects the optimal price for advertising space and the amount of advertising that determines the quality of the lower quality version.

2. The model

2.1. Setup

Consider a monopoly media firm that has developed a good having the intrinsic quality level $q_p = v > 0$. The media firm can be a broadcaster, a magazine, a software firm, a website or any other kind of firm that can embed advertisements in its product. The fixed costs related to the development of this product are sunk, and duplication carries small or zero costs. Initially, the media firm is advertising-based and does not charge consumers. However, consumers dislike advertisements. The perceived quality of the product accounting for disutility from advertisements is $q_a = v - \gamma a > 0$, where $a \in [0,1]$ is the advertising quantity and $\gamma < v$ is a measure of how annoying advertisements are perceived to be.[10] Consumers, a continuum of mass N with unit demand, are heterogeneous with respect to their marginal valuation of quality, denoted by θ. The distribution of θ is uniform on the unit interval. Hence, consumer i values the advertising-based media firm's product at $u_i = \theta_i q_a = \theta_i(v - \gamma a)$.

The specific dependence of quality on advertising allows consumers to be heterogeneous both in their perceptions of intrinsic product quality and the impact of advertising on their utilities.[11] This assumption is consistent with an interpretation that advertisements degrade, i.e., damage, the perceived quality of the product. It seems reasonable to assume that consumers who value quality more also dislike advertisements more. First, in many cases, advertising takes up space, which effectively reduces the amount of content. The reduction of content is more important for consumers who value content highly. Second, advertising requires attention from consumers. Consumers who value quality highly might have a higher opportunity cost of time and hence dislike advertisements more. Note, however, that this assumption also implies that all consumers will use the media firm's product since $q_a > 0$ and the product is free. We retain this assumption as it simplifies our analysis, although it is not a standard assumption in the literature.

Advertising quantity, a, and hence also q_a, is endogenous in the model. Advertisers, a continuum with mass *1*, are monopoly producers of new goods.[12] Advertising fills the role of informing consumers about the prices and characteristics of their goods.[13] Each advertiser has developed a new good characterized by its type σ uniformly distributed on the unit interval. The type of good indicates its purchase probability after being advertised. Goods of a higher type are more likely to be bought after being advertised. The profit margin on the goods sold by the advertisers is s. Advertiser j is willing to pay a maximum price of $\sigma_j snN$ to place an advertisement in the media firm's product, where n is the fraction of consumers viewing the advertisements attached to the media firm's product. Advertiser j profits from advertising according to $\sigma_j snN - p_a$ if there is advertising and *0* otherwise. Here, p_a denotes the price charged by the media firm for advertising space. The advertiser who is indifferent between advertising and not advertising has $\sigma_a = \frac{p_a}{snN}$, thus implying that the mass of advertising advertisers, and hence advertising quantity, is $a = 1 - \frac{p_a}{snN}$.

2.2. An advertising-based media firm

A media firm that is entirely advertising-based must decide how to optimally set the price for advertising space. Since $n = 1$, demand for advertising space is $a(p_a) = (1 - \frac{p_a}{sN})$ for $p_a \in [0, Ns]$, $a(p_a) = 0$ for $p_a > Ns$ and $a(p_a) = 1$ otherwise. The media firm's profit function is given by

$$\Pi_A(p_a) = p_a a(p_a), \tag{1}$$

where the price for ad-space is the decision variable.

Lemma 1. *When the media firm is advertising-based, the profits are* $\Pi_A = \frac{sN}{4}$ *and the advertising quantity is* $a_a = \frac{1}{2}$.

(Proofs to all lemmas and propositions are found in Appendix.) When the firm is advertising-based, all consumers use the product and view the advertisements. The media firm can charge more for advertising space if advertisers' profit margins (s) are higher or if there are more consumers (N) in the market viewing the advertisements. How annoying consumers perceive advertisements to be (γ) does not affect prices or advertising quantity since $q_a > 0$ (the market is covered).

2.3. Introducing the option to pay to remove advertisements

Let us now examine the media firm's incentive to introduce the option of paying to remove advertisements, i.e., the incentive to bring out a higher quality product not

[8] E.g., Anderson and Coate (2005), Crampes et al. (2005) and Gabszewicz et al. (2004).

[9] E.g., Caillaud and Jullien (2003), Rochet and Tirole (2003) and Armstrong (2006).

[10] That consumers dislike advertising is in line with Holden (1993), Hansen and Kyhl (2001), Prasad et al. (2003) and Anderson and Gans (2008). For the markets we consider, this seems to be a reasonable assumption since consumers are observed to be willing to pay to remove advertisements and thus, they clearly reveal a preference for consuming the product without ads.

[11] A heterogeneous impact of advertising on utility is an important difference between our model and the analyses in Holden (1993) and Hansen and Kyhl (2001). Heterogeneous aversion to advertising is part of the analysis in Prasad et al. (2003), but they do not consider to what extent advertisements have an impact on utility. Essentially, the assumption is that $\gamma = 1$. Moreover, they only consider two consumer types (θ_H and θ_L).

[12] So $N > 1$ implies that there are relatively more consumers than advertisers.

[13] For a discussion of the different roles of advertising see, for example, Bagwell (2007). The advertising market used in this model is partly adopted from Anderson and Coate (2005).

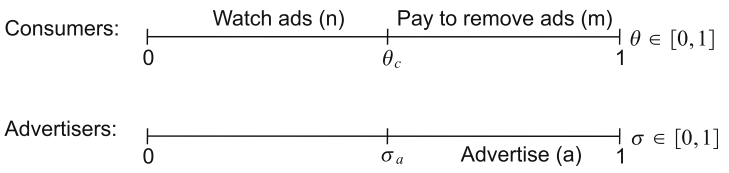

Fig. 1. Consumers either watch advertisements or pay to remove them. Advertisers either advertise or not.

damaged by advertisements, for which it charges a positive price p_c.

Let θ_c denote the consumer who is indifferent between paying to remove advertisements and using the advertising-based version for free. Given prices, it must then be the case that consumers with $\theta \in [\theta_c, 1]$ pay while consumers with $\theta \in [0, \theta_c]$ use the free version. The location of the indifferent consumer can be obtained from the indifference equation $\theta_c q_p - p_c = \theta_c q_a$ or

$$\theta_c v - p_c = \theta_c(v - \gamma a). \tag{2}$$

Solving for θ_c, we obtain $\theta_c = \frac{p_c}{\gamma a}$. Demand for the advertising-based version is then given by $Nn(p_c, a) = N\left(\frac{p_c}{\gamma a}\right)$ for $p_c \in [0, \gamma a]$, by N for $p_c > \gamma a$ and by 0 otherwise. Demand for the fee-based version is $Nm(p_c, a) = N[1 - n(p_c, a)]$. All consumers acquire the media firm's product, but only a fraction n views the ads. Demand for ad-space is, as above, $a(p_a, n) = \left(1 - \frac{p_a}{snN}\right)$ for $p_a \in [0, snN]$, 0 for $p_a > snN$ and 1 otherwise. This is illustrated in Fig. 1.

The timing of the decisions is set as follows. First, the media firm sets prices p_c and p_a. Then, consumers and advertisers observe these prices and make their purchase and participation decisions. This timing captures a setting where consumers and advertisers arrive in an alternating fashion, so that neither consumers nor advertisers (as a whole) move first. To account for the fact that the demand for ad-space depends on the demand for the ad-based version and vice versa, we assume that consumers form expectations (which must be fulfilled in equilibrium) regarding the participation of advertisers and that advertisers form similar expectations (which also must be fulfilled in equilibrium) regarding the participation of users. Hence, we simultaneously solve $n = \frac{p_c}{\gamma a}$ and $a = 1 - \frac{p_a}{snN}$.[14] This system has the solutions $n(p_c, p_a) = \frac{p_a}{sN} + \frac{p_c}{\gamma}$ and $a(p_c, p_a) = \frac{sNp_c}{sNp_c + p_a\gamma}$, which give the share of consumers viewing the advertisements and demand for ad-space as functions of the price for removing advertisements and the price for ad-space. Demand for the advertising-based version is $Nn(p_c, p_a)$ and demand for the fee-based version is $N[m(p_c, p_a)] = N[1 - n(p_c, p_a)]$.

The media firm sets prices to maximize

$$\Pi_{F+A} = N[m(p_c, p_a)]p_c + a(p_c, p_a)p_a \tag{3}$$

subject to the constraints $0 \leqslant p_a \leqslant sNn(p_c, p_a)$ and $0 \leqslant p_c \leqslant \gamma a(p_c, p_a)$. Solving this problem for an interior solution gives the following main proposition of our paper:

Proposition 1. *The option to pay to remove advertisements is introduced if $\gamma > \frac{1}{2}s$ since an interior solution is obtained for $\frac{s}{\gamma} \in \left]\frac{1}{2}, 2\right[$. The profits are $\Pi_{F+A} = N\frac{((\gamma+s)^3)}{27\gamma s}$ and are increasing in γ and s. The profits from consumers are increasing in γ and decreasing in s. The profits from advertisers are decreasing in γ and increasing in s. Advertising quantity is $a = \frac{1}{3} + \frac{\gamma}{3s} > \frac{1}{2}$. It is higher than when the firm is entirely ad-based and it is increasing in γ.*

This proposition shows that the media firm makes its decision to introduce the option to pay to remove advertisements based on whether or not the additional revenues from paying consumers are sufficient to offset the losses from not mediating those consumers to advertisers. The revenues from paying consumers increase if advertisements cause more disutility (γ increases). The revenues from mediating those consumers to advertisers increase if advertisers' profit margins (s) increase. Hence, it is the relation between γ and s that is of importance.

The media firm also controls advertising quantity, however, through the price for advertising space. When the option to pay to remove advertisements is introduced (a product of quality $q_p = v$), the media firm has an incentive to induce more consumers to pay to remove advertisements. It can reduce the negative effect of the free advertising-based version (of quality $q_a = v - \gamma a$) on the paid version by reducing p_a, which in turn increases a. This leads to a reduction in q_a, and more consumers thus choose to pay to obtain q_p. This result is similar to the results from standard second-degree price discrimination models with endogenous quality levels (e.g., Mussa and Rosen, 1978). The lower quality version of the product has its quality distorted downward to allow for a higher price on the high-quality version. The incentive to distort quality downward increases as γ increases since the same reduction in p_a (leading to an increase in a) has a larger effect on perceived quality and thereby on the firm's revenues. Hence, and perhaps surprisingly, advertising quantity may be greater the more annoying advertisements are.

Finally, Proposition 1 provides two empirically testable predictions. First, when paying to remove advertisements is possible, advertising quantity in the free version should be higher than when it is not. Second, advertisements should be more annoying and intrusive if the option to pay to remove advertisements is present. There seems to be some anecdotal evidence in support of this result. As mentioned by Prasad et al. (2003), Slashdot.org increased the number of advertisements displayed when it introduced the option to pay to remove them. The same seems

[14] Alternative variations of the model could have consumers first committing to purchase the advertising-based version and then advertisers deciding on participation or, alternatively, have advertisers first committing to advertise and then consumers making their purchase decisions. Such modifications of the model change the expressions for demand since one side of the market observes participation on the other side, but the analysis is otherwise unaffected.

to be true for Gamespot.com. Compared to other sites operated by CNET Networks that do not allow consumers to pay to remove advertisements, Gamespot.com seems to have the most annoying and intrusive advertisements.

3. Welfare implications

What are the welfare implications of introducing the option of paying to remove advertisements? Suppose that we define total surplus to be $TS = CS^F + CS^A + AS + \Pi$, where CS^F is the consumer surplus for consumers using the fee-based version and CS^A is the surplus for consumers using the advertising-based version, AS is advertiser surplus, and Π is media firm profits. The remaining parts of media firm profits are defined as:

$$CS^F(\theta_c, p_c) = N\int_{\theta_c}^{1} \theta v - p_c d\theta, \tag{4}$$

$$CS^A(\theta_c, p_c, a) = N\int_{0}^{\theta_c} \theta(v - \gamma a) d\theta, \tag{5}$$

$$AS(\sigma_a, p_a, n) = \int_{\sigma_a}^{1} \sigma s n N - p_a d\sigma. \tag{6}$$

By substituting optimal values of p_c, θ_c, a, σ_a and n, we obtain the following proposition:

Proposition 2. *Introducing the option to pay to remove advertisements reduces the consumer surplus for*

(i) *paying consumers by* $\Delta CS^F = \frac{(\frac{s}{\gamma}-2)^3 N\gamma}{108\frac{s}{\gamma}} < 0$, *and for*

(ii) *consumers still watching advertisements, by* $\Delta CS^A = \frac{(\frac{s}{\gamma}-2)\left(1+\frac{s}{\gamma}\right)^2 N\gamma}{108\frac{s}{\gamma}} < 0$.

Both the advertiser's and the media firm's surplus increases. The total surplus decreases if $\frac{s}{\gamma} \in \left]\frac{1}{2}, \frac{25+3\sqrt{41}}{32}\right]$ *and increases if* $\frac{s}{\gamma} \in \left[\frac{25+3\sqrt{41}}{32}, 2\right[$.

The consumer surplus decrease for consumers using the free advertising-based version since advertising quantity is increased when the option to pay to remove advertisements is available. Consumers paying to remove advertisements are also worse off since the price they pay to remove them is higher than the disutility advertisements would have caused them had this option not been available. The media firm obviously benefits since it could always choose not to introduce this option. Advertisers benefit because the price for advertising must decrease for advertising quantity to increase. Hence, the impact on total welfare depends on the gains to the media firm and to advertisers relative to the losses in consumer surplus.[15]

Note that one potential welfare effect of introducing the option to pay to remove advertisements might be missing from our setup due to the market coverage assumption. If consumers varied in their dislikes of advertisements, γ, then some consumers might not use the media firm's product when the media firm is ad-based only. In this case, there could be a positive effect on consumer surplus by allowing consumers to pay to remove advertisements, since some of the consumers who did not use the firm's free product might do so if they could pay to remove the ads.

4. Discussion and extensions

4.1. An entirely fee-based media firm

In the above analysis, the media firm did not have the option to stop selling the free advertisement-based version of its product. The media firm might have an incentive to do that if the intrinsic quality of the product, v, is sufficiently large. To see this, suppose that the media firm is entirely fee-based and offers no advertising-based product. Let the consumer who is indifferent between buying and not buying the fee-based product be of type θ_f. Then, consumers of type $\theta \in [\theta_f, 1]$ buy the product. The location of θ_f is given by

$$\theta_f v - p_f = 0. \tag{7}$$

Demand for the fee-based product is then $Nm(p_f) = N(1-\theta_f) = N\left(1-\frac{p_f}{v}\right)$ for $p_f \in [0, v]$, $Nm(p_f) = 0$ for $p_f > v$ and $Nm(p_f) = N$ otherwise. The media firm's profit function is $\Pi_F(p_f) = p_f Nm(p_f)$.

The media firm chooses the price to maximize profits.

Lemma 2. *When the media firm is fee-based, the price for the product is* $\frac{v}{2}$ *and the profits are* $\Pi_F = N\frac{v}{4}$.

When the media firm is fee-based, a higher quality product implies higher profits. An increase in the number of consumers has the same effect.[16]

Using Lemma 2, we can now compare profit levels between cases where the firm is entirely advertisement-based, allows for paying to remove advertisements, and has no advertisements. Then, we obtain the following proposition.

Proposition 3. *For* $\frac{s}{\gamma} \in [0, \frac{1}{2}]$, *only a fee-based version is optimal. For* $\frac{s}{\gamma} \in \left]\frac{1}{2}, 2\right[$ *and* $v < v^*$, *where* v^* *is such that* $\Pi_F - \Pi_{A+F} = N\frac{v^*}{4} - N\frac{(\gamma+s)^3}{27\gamma s} = 0$, *a fee-based version and an advertising-based version should be made available so that consumers can pay to remove advertisements. If* $\frac{s}{\gamma} \in \left]\frac{1}{2}, 2\right[$ *and* $v \geqslant v^*$, *only a fee-based version is optimal. For* $\frac{s}{\gamma} \in [2, \infty[$ *and* $v < v^{**}$, *where* v^{**} *is such that* $\Pi_F - \Pi_A = N\frac{v^{**}}{4} - N\frac{s}{4} = 0$, *the media firm should be purely advertising-based. If* $\frac{s}{\gamma} \in [2, \infty[$ *and* $v \geqslant v^{**}$, *only a fee-based version is optimal.*

The intuition for the above proposition is similar to that for Proposition 1, and we only add the possibility of not taking on any advertising. Consumer willingness to pay for a fee-based version is related to how annoying advertisements are (γ). Advertisers' willingness to pay for adspace is related to their profits for reaching a consumer (s). Hence, the relation between the two variables deter-

[15] The result that consumers are harmed and that the impact on overall welfare is ambiguous is in line with the analyses of Holden (1993) and Hansen and Kyhl (2001).

[16] As consumers are heterogeneous with respect to quality, it might be asked whether the media firm would find it optimal to price discriminate by offering two versions of the product, v_H and v_L, such that $v_H > v_L$, but no version with advertisements. It can be shown that this kind of price discrimination is not optimal. The reason is that the marginal costs are zero and not affected by the quality level. Hence, there is no reduction in marginal costs when quality is reduced. It is then optimal to only offer one version (with the current utility specification).

mines the source of revenues on which the media firm should focus. However, it may be the case that simply selling the product to consumers and not involving advertisers is optimal. This is the case if product quality (v) is sufficiently high. Then, because a free advertising-based version decreases the sales of the product without advertisements, only offering a fee-based version is optimal.

4.2. On advertisers' profit margins

A possible extension of this framework would be to consider the case where the profit margins of the advertisers are dependent on consumer valuations of quality, θ. Relaxing the assumption of independence would have at least two implications.

First, a formal model of how advertisers price their goods would be needed. Their pricing decision would depend on how many consumers use the ad-based version offered by the media firm and, hence, on the price to remove advertisements.[17] Second, consumers would be left with some surplus from purchasing advertisers' goods and hence have to balance the disutility from having advertisements with possible gains from being informed about a useful product, which would generate utility.

4.3. Market coverage, product quality and variety

An important welfare issue involves how the option of paying to remove advertisements affects the media firm's dynamic incentives to invest in increasing the fixed product quality v. Since we have assumed that $q_a > 0$ and that one version is free, all consumers always purchase one of the media firm's products (the market is covered). Hence, the media firm has no incentives to invest in increasing v if it is advertising-based or introduces the option to pay to remove advertisements. Moreover, our setup unfortunately does not allow us to consider the question of how paying to remove advertisements affects the variety of the content supplied by the media firm, which is another important welfare issue in the media literature. In a related paper, Anderson and Gans (2008) show, with respect to ad-avoidance technologies, that a media firm's content might be of lower quality and be tailored to appeal to a wider range of consumers (i.e., exhibit less variety) if consumers can use advertising avoidance technologies. However, in our setting, the media firm profits from ad-avoiders, which is not the case in Anderson and Gans (2008). Hence, it is not clear that their results transfer to our setting. Unfortunately, extending the current model to relax the assumption of market coverage and to study these issues has proven to be less than straightforward.

5. Conclusion

In this paper, we have analyzed a monopoly media firm's incentives to introduce an option to pay to remove advertisements from an otherwise ad-based product. The monopolist will introduce the option if the disutility from advertisements experienced by consumers is sufficiently high relative to advertisers' profit margins from reaching users. The media firm trades off revenue from paying consumers against the potential advertising revenue that can be earned by mediating those consumers to advertisers. We show that because the free advertising-based product negatively impacts the sales of a paid version without advertisements, it is optimal for the firm to increase the quantity of advertisements in the free version when the option to pay to remove ads is introduced. Furthermore, increasing advertising quantity is a more effective way to reduce the perceived quality of the free version if the consumers' dislike advertisements. Hence, advertising quantity in the free version may increase the disutility caused by an advertisement.

We further show that introducing the option to pay decreases consumer welfare, while both media firm and advertiser profits increase. Consumer welfare decreases because consumers using the free version see more advertisements, and consumers paying to remove advertisements pay a price that causes more disutility than the advertisements would have caused had the option to pay not been available.

These results have two empirical predictions. First, the observed advertising quantity should be higher if the option to pay to remove advertisements is available. Second, advertisements should be more annoying and intrusive if the option to pay to remove advertisements is present. Empirically testing these predictions would be interesting, and they seem to be affirmed by casual observations.

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Appendix A. Proof of Lemma 1

The first-order condition is given by $1 - \frac{2p_a}{sN} = 0$ which gives $p_a = \frac{sN}{2}$. The second-order condition is satisfied since $-\frac{2}{sN} < 0$. Substituting $p_a = \frac{sN}{2}$ in $a(p_a)$ and $\Pi_A(p_a)$ gives $a_a = \frac{1}{2}$ and $\Pi_A = \frac{Ns}{4}$.

Appendix B. Proof of Proposition 1

Assume an interior solution so that none of the constraints are binding. Taking the first-order conditions and

[17] Alternatively, only the profit margin could be dependent on θ and the pricing problem could be bypassed.

solving the resulting simultaneous equation system yields two solutions for $\{p_c, p_a\}$ given by $\left\{\frac{(s+\gamma)^2}{9s}, \frac{1}{9}N\left(s-\gamma+\frac{2s^2}{\gamma}\right)\right\}$ and $\left\{0, N\frac{s(s+\gamma)}{\gamma}\right\}$. The determinants of the principal minors evaluated at each solution point are $\left\{\frac{2}{3}N\left(\frac{9}{s+\gamma}-\frac{1}{s}-\frac{7}{\gamma}\right), \frac{3}{s^2}\right\}$ and $\{2N\left(\frac{1}{s+\gamma}-\frac{2}{\gamma}\right), -\frac{1}{s^2}\}$. They should alternate in sign such that the first is non-positive and the second is non-negative for the solution to be a maximum. Since $-\frac{1}{s^2}<0$, the optimum cannot be the solution characterized by $\{0, N\frac{s(s+\gamma)}{\gamma}\}$. The second solution satisfies the second-order conditions if $\frac{2}{3}N\left(\frac{9}{s+\gamma}-\frac{1}{s}-\frac{7}{\gamma}\right)<0$. Denote the candidate solution by stars. Use $n(p_c^*, p_a^*)$ and $a(p_c^*, p_a^*)$ to obtain expressions for demand in terms of the exogenous variables. This gives $n^*=\frac{s+\gamma}{3\gamma}$ and $a^*=\frac{s+\gamma}{3s}$. It is now apparent that the solution is an interior optimum only if $\frac{s}{\gamma}\in\left]\frac{1}{2}, 2\right[$, since otherwise the prices are not consistent with demand configurations in the range $Nn\in[0,N]$ and $a\in[0,1]$. Since $\frac{2}{3}N\left(\frac{9}{s+\gamma}-\frac{1}{\gamma}-\frac{7}{\gamma}\right)<0$ for this range, the candidate solution is the optimum. At the boundary where $\frac{s}{\gamma}=2$, the problem reduces to that where only the advertising-based version is offered ($n=1$ and $a=\frac{1}{2}$). At the other boundary $\frac{s}{\gamma}=\frac{1}{2}$, all advertisers buy ad-space ($a=1$) so that the lower quality version has the quality $q_a=v-\gamma$. Half of the consumers pay to remove advertisements ($n=\frac{1}{2}$). For $\frac{s}{\gamma}\in\left]\frac{1}{2}, 2\right[$, total profits are increasing in γ and s, since $\frac{\partial \Pi_{F+A}}{\partial \gamma}=\frac{N(2\gamma-s)(\gamma+s)^2}{27\gamma^2 s}>0$ and $\frac{\partial \Pi_{F+A}}{\partial s}=\frac{N(2s-\gamma)(\gamma+s)^2}{27\gamma s^2}>0$. Profits can be split into profits from consumers and from advertisers. Profits from consumers are given by $\Pi^C_{A+F}=N\frac{(2\gamma-s)(\gamma+s)^2}{27\gamma s}$ and profits from advertisers are given by $\Pi^A_{A+F}=N\frac{(2s-\gamma)(\gamma+s)^2}{27\gamma s}$. Then, it is the case that $\frac{\partial \Pi^C_{A+F}}{\partial \gamma}=N\frac{4\gamma^3+3\gamma^2 s+s^3}{27\gamma s^2}>0$, $\frac{\partial \Pi^C_{A+F}}{\partial s}=-N\frac{2(\gamma^3+s^3)}{27\gamma^2 s}<0$, $\frac{\partial \Pi^A_{A+F}}{\partial \gamma}=-N\frac{2(\gamma^3+s^3)}{27\gamma^2 s}<0$ and $\frac{\partial \Pi^A_{A+F}}{\partial s}=N\frac{4s^3+3\gamma s^2+\gamma^3}{27\gamma s^2}>0$. For $\frac{s}{\gamma}\in\left]\frac{1}{2}, 2\right[$, advertising quantity is $a=\frac{s+\gamma}{3s}$. This is larger than $\frac{1}{2}$, which is the advertising quantity when the media firm is entirely advertising-based (by Lemma 1).

Appendix C. Proof of Proposition 2

The consumer and advertiser surplus if the media firm allows consumers to pay to remove advertisements is given by:

$$CS^A_{F+A}=N\int_0^{\theta_c^*}\theta(v-a^*)d\theta = N\frac{(s-2\gamma)(2\gamma(s+v)^2-3sv(4\gamma+s)}{54s\gamma^2}, \quad (8)$$

$$CS^F_{F+A}=N\int_{\theta_c^*}^1 \theta v-p_c^* d\theta = N\frac{(\gamma+s)^2(3sv-\gamma(\gamma+s))}{54s\gamma^2} \quad (9)$$

$$AS_{F+A}=\int_{\sigma_a^*}^1 \sigma s N n^*-p_a^* d\sigma = N\frac{(s+\gamma)^3}{54s\gamma}, \quad (10)$$

where $\theta_c^*=\frac{s+\gamma}{3\gamma}, \sigma^*=\frac{2s-\gamma}{3s}, a^*=\frac{1}{3}+\frac{\gamma}{3s}, p_c^*=\frac{(s+\gamma)}{9s}$ and $p_a^*=N\frac{1}{9}\left(s+\frac{2s}{\gamma}-\gamma\right)$. The surplus for these consumers under the ad-based business model, i.e., with $\theta_c^*=\frac{s+\gamma}{3\gamma}$, $\sigma^*=\frac{2s-\gamma}{3s}$, $a^*=\frac{1}{2}$ and $p_a^*=N\frac{s}{2}$, would have been:

$$CS^A_{A'}=N\int_0^{\theta_c^*}\theta(v-a^*)d\theta = N\frac{(g+s)^2(2v-\gamma)}{36\gamma^2} \quad (11)$$

$$CS^F_{A'}=N\int_{\theta_c^*}^1 \theta(v-a^*)d\theta = N\frac{(2\gamma-s)(4\gamma+s)(2v-\gamma)}{36\gamma^2}, \quad (12)$$

where the sum of these two is $N\frac{(2v-\gamma)}{4}$ and the total advertiser surplus under the ad-based business model is $AS_A=N\frac{s}{8}$. Consider the following differences in surplus. Let $\Delta CS^F=CS^F_{F+A}-CS^F_{A'}$ denote the difference in surplus for consumers who choose to pay to remove advertisements when this option is available to them. Let $\Delta CS^A=CS^A_{F+A}-CS^A_{A'}$ be the difference in surplus for consumers who still choose to use the advertising-based version when the option to pay to remove advertisements is available. Denote the difference in advertiser surplus by $\Delta AS=AS_{F+A}-AS_A$ and the difference in firm profits by $\Delta\Pi=\Pi_{F+A}-\Pi_A$. Let r be the ratio $\frac{s}{\gamma}$. Then, the differences in surplus can be expressed as

$$\Delta CS^F=\frac{(r-2)^3 N\gamma}{108r}, \quad (13)$$

$$\Delta CS^A=\frac{(r-2)(1+r)^2 N\gamma}{108r}, \quad (14)$$

$$\Delta AS=\frac{(r-2)^2(1+4r)N\gamma}{216r}, \quad (15)$$

$$\Delta\Pi=\frac{(r-2)^2(1+4r)N\gamma}{108r}. \quad (16)$$

The difference in advertiser surplus and firm profits is positive for $r\in\left]\frac{1}{2}, 2\right[$. The difference in consumer surplus is negative for both consumer segments. The effect on total welfare is equal to $\Delta W=\Delta AS+\Delta CS^F+\Delta CS^A+\Delta\Pi=\frac{1}{216r}N\gamma(r-2)(4+r(16r-25))$. The direction of the effect on total welfare is ambiguous and depends on the $sign\{4+r(16r-25)\}$.

Appendix D. Proof of Lemma 2

The first-order condition is given by $N\left(1-\frac{2p_c}{v}\right)=0$, which gives $p_c=\frac{v}{2}$. The second-order condition is satisfied since $-N\frac{2}{v}<0$. Substituting $p_c=\frac{v}{2}$ in $\Pi_F(p_c)$ gives $\Pi_F=N\frac{v}{4}$.

Appendix E. Proof of Proposition 3

Through the proof of Proposition 1, $\Pi_F\geqslant\Pi_{A+F}>\Pi_A$ if $\frac{s}{\gamma}\leqslant\frac{1}{2}$ since $\gamma\leqslant v$. This result gives the first part of the proposition. If $\frac{s}{\gamma}\in\left]\frac{1}{2}, 2\right[$, then $\Pi_{A+F}>\Pi_A$ by the proof of Proposition 1, but it may be that $\Pi_F\geqslant\Pi_{A+F}$. This is the case for $v\geqslant v^*$ where v^* is such that $\Pi_F-\Pi_{A+F}=N\frac{v^*}{4}-N\frac{(\gamma+s)^3}{27\gamma s}=0$. This gives the second part. If $\frac{s}{\gamma}\geqslant 2$, then $\Pi_A>\Pi_{A+F}$ by the proof of Proposition 1, but it may be that $\Pi_F\geqslant\Pi_A$. This is the case for $v\geqslant v^{**}$ where v^{**} is such that $\Pi_F-\Pi_A=N\frac{v^{**}}{4}-N\frac{s}{4}=0$.

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