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Financing of Media Firms: Does Competition Matter?*

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Abstract: This paper analyses how competition between media firms influences the way they are financed. In a setting where monopoly media firms choose to be completely financed by consumer payments, competition may lead the media firms to be financed by advertising as well. The closer substitutes the media firms' products are, the less they rely on consumer payment and the more they rely on advertising revenues. If media firms can invest in programming, they invest more the less differentiated the media products are perceived to be.

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1 Introduction

Media firms can generate revenues in various ways. Some TV channels are for example financed by advertising revenue, while others rely on direct payment from their viewers. Media firms may also combine different ways to raise revenues, such as when newspapers earn revenue both from advertising and from consumer payment. Why do media firms choose different ways to earn revenues? Why do we often observe purely advertising-financed media firms, even though empirical evidence suggests that their audiences dislike commercials?[1] Why not charge the audience directly, and avoid product-damaging commercials? In answering these questions, we present a simple model showing how competition between media firms can help explain the way they are financed.

To analyze the importance of the rivalry between media firms, we consider a model of a media market where the audience dislikes advertising. The media firms can for instance be TV channels, radio channels, or newspapers (printed or electronic). Each firm is financed by advertising, direct payment from consumers, or both. We find that, in duopoly, the media firms are financed partly by advertising revenue and partly by consumer payments. The tougher the competition is, in the sense of the media products being closer substitutes, the more do the media firms rely on advertising revenues. Indeed, in the limit case where the media firms are perfect substitutes, the whole profit of the media firms comes from advertising.

In order to understand this result, note that competition in consumer prices is qualitatively different from competition in advertising prices. As is the case in more

[1] It is documented that viewers try to escape from advertising breaks on TV, see, *e.g.*, Moriarty and Everett (1994) and Danaher (1995). See also Wilbur (2004), who estimates a model of TV competition and finds viewers' disutility to be significant and positive. For printed newspapers, there are less clear answers as to whether consumers consider advertising as a good or as a bad, and there are some indications that the extent to which people consider commercials as bad varies across countries. For instance, it has been argued that newspaper readers in Europe have a more negative attitude to advertising than those in the USA (Gabszewicz, *et al.*, 2004a). Depken and Wilson's (2004) study of US magazines indicates that readers' attitude to advertising is negative in some magazines and positive in others.

traditional markets, consumer prices are *strategic complements*: if one media firm reduces the price it charges from its audience, it will be optimal for the other firm to do the same. Advertising prices, on the other hand, are *strategic substitutes;* a price reduction from one firm leads to a price *increase* from the other.[2] To see why, suppose that firm 1 reduces its advertising price. This leads to an increase in its level of advertising, which is bad for its audience. Therefore, there will be a shift of media consumers from firm 1 to firm 2. Since firm 2 will end up with a larger audience, it can respond by increasing its advertising price.

Competition in strategic complements is generally more aggressive than competition in strategic substitutes, and more so the less differentiated the products are (see, *e.g.*, Bulow, *et al.*, 1985, and Vives, 1999). In particular, firms producing identical products at identical costs will make a positive profit if they compete in strategic substitutes, but not if they compete in strategic complements. This explains why we arrive at the result that the media firms raise all their revenues from advertising if their products are perfect substitutes; the profits from consumer prices are competed away with homogenous products.

How will this analysis be affected if the media firms are able to invest in product quality, *i.e.*, undertake investments that make their products more attractive for the consumers? Improving the product quality increases the willingness to pay for the media product, and enlarges the size of the audience. In addition to this market-expansion effect, there is also a business-stealing effect: each media firm has incentives to invest in quality in order to capture part of the rival's audience. Since the audience is more prone to shift from a "low-quality" to a "high-quality" media firm the less (horizontally) differentiated the firms' products are, the business-stealing effect is strongest for media outlets that are close substitutes. The media firms therefore invest more in quality the less differentiated their products are. However, the introduction of quality investments has no effect on the relative merits of consumer payments and advertising revenue: The closer substitutes the media products are, the more the media firms rely on advertising - also when quality investments

[2] This was first shown by Nilssen and Sørgard (2001). The same result also shows up in the analyses of Gabszewicz, *et al.* (2004b) and Anderson and Coate (2005).

are available.

The rest of the paper is organized as follows. In the next Section, we relate our study to the existing literature. In Section 3, we start out with discussing the case of monopoly, showing that the monopoly media firm's choice between advertising and consumer payments depends on the strength of media consumers' disutility from advertising relative to advertisers' benefit from it. When this ratio is high, the monopolist' choice is to be completely advertising free. In Section 4, we introduce a duopoly model and find that an increase in competition, in the sense of more similar media products, makes media firms shift from consumer payments to advertising as a source of finance. Thus, competition endogenously creates a two-sided media market, with media firms financed partly by advertising revenue and partly by consumer payments, with the role of advertising increasing as competition becomes fiercer. Section 5 expands on this analysis by considering media firms' incentives to invest in quality as competition increases. We find that more competition leads to increased incentives to make quality investments but that firms' choices of source of finance are basically unaffected by the introduction of quality investments. Finally, we offer some concluding remarks in Section 6.

2 Related literature

The question of why advertising revenue is important to many media firms has received a lot of attention lately. One reason being put forward is that it may be impossible, or at least difficult, to collect money from the public in some cases. This has been used as an explanation for why so few newspapers on the Internet are financed by user payment, and why so many broadcasting firms historically have relied heavily on advertising income. However, as argued by Armstrong (2005), technological progress and new payment systems presumably make this a less important reason now than it was earlier. Another explanation for absence of user payment may be that the efficiency gains of advertising can be large compared to consumers' disutility of being interrupted by commercials. In such a case, firms may have a relatively high willingness to pay for advertising, and a media firm may

find it profitable to sell advertising space even if this should make the media firm's product less attractive for the consumers.

One important strand of the literature on media economics fixes the media firms' financing and discusses implications, particularly for the program content, of the firms being financed by either consumer payments or advertising. This includes the classic study by Spence and Owen (1977) and more recent contributions by Wurf and Cuilenburg (2001) and Peitz and Valletti (2004). In an interesting paper, Chae and Flores (1998) analyze how we should expect pay TV and advertising-financed TV to differ on certain main characteristics of the programmes they offer. Their main result is that pay TV tends to show programs for which there is a relatively small audience, but with a high willingness to pay. Advertising-financed TV, on the other hand, focuses on large markets where the audience has a relatively low willingness to pay. Chae and Flores thus focus purely on the demand side to explain how media firms are financed, while we take into account the two-sidedness of the media industries in our analysis.

The only paper we are aware of, besides ours, that considers media firms which are partly financed by advertising and partly by consumer payments, is Godes, *et al.* (2003). However, they have a different model set-up and focus. In particular, Godes, *et al.* analyze competition between different media industries (*e.g.*, newspaper and TV). Media firms within a given industry are assumed to be homogeneous, and in their main model, consumers are indifferent to the level of advertising.[3] Also Anderson (2003) endogenizes media-firm financing, but firms can only choose between being completely advertising-financed and completely financed by consumer payments. Allowing consumers to differ with respect to their dislike for commercials, he finds that pay TV and advertising-financed TV may coexist, where the viewers with the greatest dislike for ads watch pay TV. In the work of Gabszewicz, *et al.* (2005), there are both ad-avoiders and ad-lovers in the audience, but they consider

[3] In an extension, they allow the various media industries to differ with respect to the consumers' disutility of advertising, so that, for instance, commercials on TV are perceived to be more negative than commercials in newspapers. This is an interesting path of research, which we think deserves more attention.

the case of monopoly only.

Within the related literature on two-sided markets, there are several analyses of platform firms' simultaneous pricing decisions on both sides. There are, however, some important differences between our work and this literature. Consider, for example, the seminal study by Rochet and Tirole (2003).[4] They focus on the credit-card industry, with buyers on one side and merchants on the other. First of all, they have positive externalities in both directions, while we have negative externalities from advertisers to audience. Thus, prices cannot immediately be expected to be structured so as to "get both sides on board", as Rochet and Tirole put it (p. 1013). Secondly, the users of the platforms in their context have no benefit from the consumption except the transaction it creates between the two sides. In our context, on the other hand, the audience benefit from the media product in itself, and actually the more so the less the other side is present. Thus, audience demand does not, for example, depend on whether or not there is multihoming among advertisers, as is the case with buyers in Rochet and Tirole's model. With these differences in mind, the present study still contributes to the growing literature on two-sided markets by pointing out how a difference in the kind of competition on the two sides of the market (*i.e.*, strategic complements versus strategic substitutes) determines the pricing schedules. Indeed, we demonstrate that competition by itself creates the two-sidedness, since a monopoly firm may choose to have all its revenues from the audience.

3 The monopoly case

Consider a monopoly media firm. The firm's product could for instance be a TV program, a printed newspaper, or an Internet newspaper. The media consumers will interchangeably be labelled viewers and audience.

There is a continuum of consumers with measure 1. Let V denote the quantity consumed by each consumer of the product provided by the media firm, and let A

[4] For general discussions of two-sided markets, see Evans (2003), Rochet and Tirole (2004), and Armstrong (2005).

denote the quantity of advertising carried by the firm. Then, a consumer's (gross) utility of the consumed quantity is given by

$$U = V(1 - \gamma A) - \frac{V^2}{2}, \tag{1}$$

where $\gamma > 0$, so that the consumer suffers a utility loss from advertising which is greater the more advertising there is in the product and the more she consumes of it; this particular utility function is used because it is easily generalizable to the duopoly case treated in the next Section.

Each consumer has to make a direct payment $p \geq 0$ per unit of the product (*e.g.*, per copy of a newspaper). Consumer surplus is thus equal to $CS = U - pV$. Putting $\partial CS/\partial V = 0$, we find a simple expression for the audience' demand for the media product:

$$V = 1 - p - \gamma A. \tag{2}$$

The size of the audience is decreasing in the consumer price p, the advertising level A, and the parameter γ, measuring the strength of consumers' disutility from being interrupted by advertising.

For the sake of simplicity, we put the media firm's production costs equal to zero, so that its profit is

$$\Pi = AR + pV, \tag{3}$$

where R denotes the price per unit of advertising.

Consumer-good producers advertise with the media firm if the benefit of doing so is larger than the cost. For simplicity, we assume throughout that there is only one advertiser, but it can be shown that the qualitative results of the paper hold for an arbitrary number of advertisers. The producer's gross gain from advertising is naturally increasing in its advertising level and in the number of viewers exposed to the commercials. We make it simple by assuming that the gross gain equals ηAV, where $\eta > 0$ measures the strength of the advertiser's benefit from advertising. The net gain for the producer of advertising now is

$$\pi = A(\eta V - R). \tag{4}$$

The advertiser chooses the advertising level so as to maximize profit. Solving $\partial\pi/\partial A = 0$ and taking account of the non-negativity constraint on advertising, we find that the demand for advertising is

$$A = \max\left\{0, \frac{(1-p)\,\eta - R}{2\eta\gamma}\right\}. \tag{5}$$

The media firm maximizes profit with respect to p and R, subject to (2) and (5). Assuming that non-negativity constraints are fulfilled ($A \geq 0$, and $p \geq 0$), we find that $\partial\Pi/\partial p = \partial\Pi/\partial R = 0$ yields

$$p = \frac{3\eta\left(\frac{\gamma}{\eta} - \frac{1}{3}\right)}{4\gamma - \eta\left(1 - \frac{\gamma}{\eta}\right)^2} \text{ and } R = \frac{\gamma\left(\gamma + \eta\right)}{4\gamma - \eta\left(1 - \frac{\gamma}{\eta}\right)^2}. \tag{6}$$

Inserting for equation (6) in (3) and (5), we have

$$A = \frac{1 - \frac{\gamma}{\eta}}{4\gamma - \eta\left(1 - \frac{\gamma}{\eta}\right)^2} \text{ and } \Pi = \frac{\gamma}{4\gamma - \eta\left(1 - \frac{\gamma}{\eta}\right)^2}. \tag{7}$$

From equations (6) and (7), it follows that both A and p are non-negative if $\frac{\gamma}{\eta} \in \left(\frac{1}{3}, 1\right)$, in which case

$$\frac{\partial A}{\partial \gamma} < 0, \text{ and } \frac{\partial p}{\partial \gamma} > 0.$$

This shows that the media firm relies less on advertising and more on direct consumer payment the stronger is consumers' disutility from being interrupted by advertising. If $\frac{\gamma}{\eta} \geq 1$, the monopoly firm is advertising-free in optimum.

We likewise find that we for $\frac{\gamma}{\eta} \in \left(\frac{1}{3}, 1\right)$ have

$$\frac{\partial A}{\partial \eta} > 0, \text{ and } \frac{\partial p}{\partial \eta} < 0.$$

An increase in η means that it becomes relatively more profitable for the media firm to sell advertising space. Therefore, $\frac{\partial A}{\partial \eta} > 0$. However, in order to raise revenue through the advertising market, it is important for the media firm to have a large audience. The optimal consumer price is consequently decreasing in η, and the monopoly firm delivers its product to the audience for free if $\frac{\gamma}{\eta} \leq \frac{1}{3}$.

We can now state:

Proposition 1: *The monopoly media firm is financed*
i) purely by advertising $(p = 0)$ *if* $\frac{\gamma}{\eta} \leq \frac{1}{3}$*;*
ii) by a combination of advertising revenue and consumer payments if $\frac{\gamma}{\eta} \in \left(\frac{1}{3}, 1\right)$*;*
iii) purely by consumer payments $(A = 0)$ *if* $\frac{\gamma}{\eta} \geq 1$.

4 A duopoly model

Below, we consider a context with two competing media firms. The two firms determine simultaneously their advertising and consumer prices. In order to simplify the algebra and highlight the effect of media competition, we put $\gamma = \eta = 1$ in the rest of our analysis. For these parameter values, we know from Proposition 1 that a monopolist would choose to be advertising-free.

With two media firms, consumers' (gross) utility is modified to

$$U = V_1 (1 - A_1) + V_2 (1 - A_2) - \frac{1}{1+b} \left(\frac{V_1^2}{2} + \frac{V_2^2}{2} + bV_1V_2 \right). \tag{8}$$

This particular function is a one-parameter version of the standard quadratic utility function, see, *e.g.*, Vives (1999) for an exposition.[5] That one parameter is $b \in [0, 1)$, which measures the degree of horizontal differentiation between the products of the two media firms. The products are completely independent if $b = 0$, while there is no horizontal differentiation between them in the limit as $b \to 1$. More generally, the media firms' products are closer substitutes from the consumers' point of view the higher is b. The parameter is introduced in this particular way in order for there to be no effect on market size from an increase in b, only an effect on product differentiation. Putting $b = 0$ brings us to a situation with two monopoly firms, each in a situation identical to the one we discussed in the previous Section.

The consumers' demand for the media products is found by maximizing consumer surplus,

$$CS = U - p_1V_1 - p_2V_2, \tag{9}$$

[5] This utility function is the same as the one we used in Barros, *et al.* (2004) and Kind, *et al.* (2005).

with respect to V_1 and V_2. This yields the demand for firm i's product equal to

$$V_i = 1 - \frac{p_i - p_j b}{1-b} - \frac{A_i - A_j b}{1-b}, \quad i,\ j = 1,\ 2, \quad i \neq j. \tag{10}$$

Demand for the media product of a firm is thus decreasing in its own price and advertising level, and increasing in those of its rival. This reflects the fact that the consumers perceive the media products as (imperfect) substitutes.

We maintain the assumption that there is only one advertiser, which now has a profit level given by

$$\pi = A_1 V_1 + A_2 V_2 - A_1 R_1 - A_2 R_2. \tag{11}$$

To find the demand for advertising, we use equations (10) and (11) to solve $\partial\pi/\partial A_1 = \partial\pi/\partial A_2 = 0$. This yields

$$A_i = \frac{1}{2}\left(1 - p_i - \frac{R_i + bR_j}{1+b}\right), \quad i,\ j = 1,\ 2, \quad i \neq j. \tag{12}$$

Similarly to the monopoly case, the profit level of media firm i equals

$$\Pi_i = A_i R_i + p_i V_i, \quad i = 1, 2. \tag{13}$$

We are now ready to note the following crucial property of our model of media competition:

Proposition 2: *Consumer payments are strategic complements and advertising prices are strategic substitutes.*

This result follows from equations (10), (12), and (13), from which we find that $\frac{\partial^2 \Pi_i}{\partial p_i \partial p_j} = \frac{b}{2(1-b)} > 0$, and $\frac{\partial^2 \Pi_i}{\partial R_i \partial R_j} = -\frac{b}{2(1+b)} < 0$.

Proposition 2 shows that there is an important difference between the two markets in which the media firms operate. In the consumer market, an increase in one firm's price would provide the other firm with incentives to increase its price too. This is in line with the normal textbook depiction of price competition. Things are quite different in the advertising market, though. As equation (12) shows, the demand for advertising facing media firm i is decreasing not only in its own price but also in that of the rival firm, R_j (for $b > 0$). To see why, suppose that R_j increases. This causes the advertising level at that media firm to decrease, making it relatively

more attractive for the audience. Some viewers will therefore shift to media firm j from media firm i, and more so the closer substitutes the media firms are. Due to a smaller audience, the demand for advertising at media firm i is reduced. So if media firm 1, say, were to increase its advertising price, it would sell less advertising. And since advertising is a nuisance to consumers, this would result in a shift in audience to media firm 1 from media firm 2, which consequently experiences a smaller demand for advertising. Thereby, media firm 2 will have an incentive to *reduce* its advertising price. In other words, firms' advertising prices are strategic substitutes.

The fact that consumer payments are strategic complements and advertising prices strategic substitutes has important implications for how the competition between the media firms works. Competition in strategic complements is more aggressive than competition in strategic substitutes, and more so the less differentiated the services are (*e.g.*, Bulow, *et al.*, 1985, and Vives, 1999). As competition becomes fiercer and b increases, the media firms' equilibrium price to consumers therefore gets lower while their advertising price gets higher. Thus, competitive forces make the media firms choose to be partly financed by advertising, in contrast to the monopolist case treated in the previous Section, and in the limit as b tends to 1, they are completely advertising financed.

To show this, we maximize profit (13) subject to the audience function (10) and the demand for advertising (12). Solving $\partial\Pi_i/\partial p_i = \partial\Pi_i/\partial R_i = 0$ simultaneously for the two firms gives rise to a symmetric equilibrium with the following prices:

$$R_i = \frac{1+b}{2+b}, \text{ and } p_i = \frac{1-b}{2-b}, \quad i = 1, 2. \tag{14}$$

By insertions in (10) and (12), we find that advertising quantities and audience sizes equal

$$A_i = \frac{b^2}{2\left(4-b^2\right)}, \text{ and } V_i = \frac{4+2b-b^2}{2\left(4-b^2\right)}, \quad i = 1, 2. \tag{15}$$

Thus, the firms' profits equal

$$\Pi_i = \frac{4-3b^2}{\left(4-b^2\right)^2}, \quad i = 1, 2.$$

Note that $\frac{d\Pi_i}{db} < 0$; the more competition the firms face, the lower is profit.

It is now useful to define S_i as consumer revenue's share of total revenue in firm i:

$$S_i = \frac{p_i V_i}{p_i V_i + A_i R_i} \tag{16}$$

Because of symmetry, we can write $S = S_1 = S_2$. Using equations (14) and (15), we express S as a function of b:

$$S(b) = \frac{(1-b)(2+b)(4+2b-b^2)}{2(4-3b^2)}; \tag{17}$$

Here, $S'(b) < 0$, $S(0) = 1$, and $\lim S(b)_{b \to 1} = 0$. We can therefore conclude:

Proposition 3: *Consumer revenue as share of total revenue is lower the closer substitutes the media firms' products are. At $b = 0$, the media firms are completely financed by consumer payments, while they are completely financed by advertising in the limit as $b \to 1$.*

The equilibrium outcome is illustrated in Figure 1, where we graph advertising revenue ($A_i R_i$) and consumer revenue ($p_i V_i$) as a function of b. The Figure shows clearly that an increase in media competition leads to a shift from consumer payments to advertising as source of revenue.

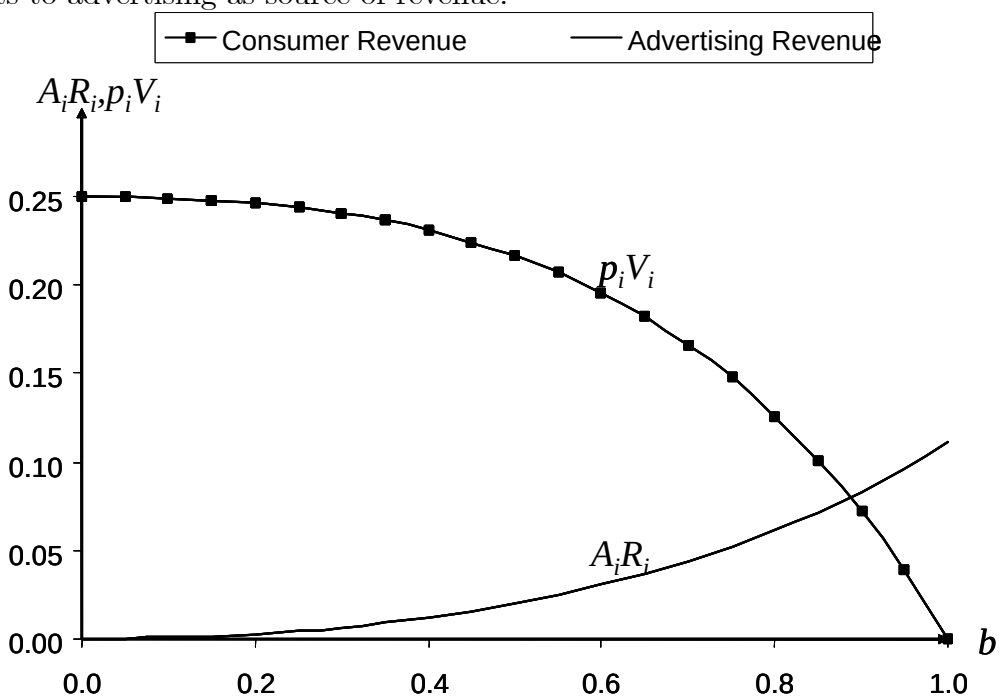

Figure 1: *Revenue from consumers and advertisers.*

From equation (15), we get another interesting feature of our model:

Proposition 4: *The media firms' audiences are larger the closer substitutes their products are:* $\frac{dV_i}{db} > 0, i = 1, 2$.

There are two effects on the audience sizes as b increases: Consumer prices go down, having a positive impact on audience sizes. At the same time, advertising goes up, having a negative impact. Since an increase in b means that competition increases - reducing the media firms' ability to utilize their market power over the consumer - the former effect dominates. Thus, the closer substitutes the two media firms produce, the larger the size of the audience. This is similar to the effect we find in more traditional markets, where stronger competition leads to higher output.

In combination, Propositions 3 and 4 predict that media firms that are mainly advertising financed have relatively large audiences. However, this is not because they seek a broader public as such. On the contrary, as shown above, a profit-maximizing monopoly would choose to have no advertising, high user payments and a relatively small audience. This fits well with the observation that pay-TV channels (and specialized Internet sites with user payment) typically have relatively few viewers.[6]

5 Investments in quality

In the above analysis, a media firm could affect its attractiveness only through changes in its advertising and consumer prices. We now extend our analysis by incorporating the ability of a media firm to invest in content quality (*e.g.*, programming). Even though this opens up a new arena for competition between the media firms, we will show below that the relative merit of the two sources of financing is unaltered: As competition gets stronger, the importance of consumer payments decreases, and that of advertising increases.

The extension calls for a respecification of consumer preferences. We accordingly

[6] This effect would not show up in a standard Hotelling framework, where the total number of consumers is given. See also the discussion in Section 6.

modify the utility function in (8) to:

$$U = V_1 (1 + Q_1 - A_1) + V_2 (1 + Q_2 - A_2) - \frac{1}{1+b} \left(\frac{V_1^2}{2} + \frac{V_2^2}{2} + bV_1V_2 \right), \qquad (18)$$

where $Q_i \geq 0$ $(i = 1, 2)$ measures the consumers' perceived quality of the content provided by media firm i.[7] Thus, a consumer benefits more from a media product the higher its quality is, and more so the more she consumes of it. Our earlier analysis corresponds to the special case where quality is fixed at $Q_1 = Q_2 = 0$.

Maximization of consumer surplus now implies that firms have the following demand functions from viewers:

$$V_i = 1 - \frac{p_i - p_j b}{1-b} - \frac{A_i - A_j b}{1-b} + \frac{Q_i - Q_j b}{1-b}, \qquad i, j = 1, 2, \quad i \neq j. \qquad (19)$$

This gives rise to the following demand for advertising, where account is taken of the media firms' quality investments:

$$A_i = \frac{1}{2} \left(1 - p_i - \frac{R_i + bR_j}{1+b} + Q_i \right), \qquad i, j = 1, 2, \quad i \neq j. \qquad (20)$$

The profit function of each media firm is as before, except for the costs incurred from investing in content quality:

$$\Pi_i = A_i R_i + p_i V_i - \varphi (Q_i), \quad i = 1, 2, \qquad (21)$$

where $\varphi(\cdot)$ is assumed to satisfy the second-order condition for an interior solution. See Appendix for a precise statement of this condition.

We assume that the firms simultaneously determine how much to invest in quality (*i.e.*, each firm choosing Q_i, $i = 1, 2$) at stage 1, while they at stage 2 play the same pricing game as we analyzed above (each firm choosing R_i and p_i, $i = 1, 2$).

We solve stage 2 by maximizing Π_i with respect to p_i and R_i $(i = 1, 2)$, subject to (19) and (20). This yields

$$R_i = \frac{1+b}{2+b} \left(1 + \frac{2Q_i - bQ_j}{2-b} \right), \; i, j = 1, 2, \; i \neq j, \qquad (22)$$

[7] By "quality", we mean anything that make the content more attractive for the consumers. This could, *e.g.*, be a more popular presenter on TV or better paper quality in a newspaper.

and

$$p_i = \frac{1-b}{2-b}\left(1 + \frac{(2-b^2)\,Q_i - bQ_j}{2-b^2-b}\right),\ i,j = 1,2,\ i \neq j. \tag{23}$$

By insertions in (20) and (19), we have

$$A_i = \frac{b^2}{2\,(4-b^2)}\,(1+Q_i)\,,\ i = 1,2, \tag{24}$$

and

$$V_i = \frac{4+2b-b^2}{2\,(4-b^2)}\left(1 + \frac{(4-3b^2)\,Q_i - b\,(2-b^2)\,Q_j}{4-3b^2-b\,(2-b^2)}\right),\ i,j = 1,2,\ i \neq j. \tag{25}$$

At stage 1, the two media firms decide on how much to invest in quality. Setting $\partial\Pi_i/\partial Q_i = 0$ for $i = 1,2$ we find that each firm's optimal quality investment level at stage 1 is implicitly given by:

$$\frac{\varphi'(Q_i)}{1+Q_i} = \frac{8+4b-4b^2-b^3}{(4-b^2)^2},\ i = 1,2. \tag{26}$$

From equation (26), we find that (see Appendix):

$$\frac{dQ_i}{db} > 0.$$

To see why the quality level is increasing in b, it is useful to consider the effects of quality improvement on revenues from advertising and user payments separately. For the advertising market, we find from equations (22) and (24) that

$$\frac{\partial R_i}{\partial Q_i} = 2\frac{1+b}{4-b^2} > 0,\ \text{and}\ \frac{\partial A_i}{\partial Q_i} = \frac{b^2}{2\,(4-b^2)} > 0, \tag{27}$$

i.e., media firm i will charge a higher advertising price and sell a larger number of advertising banners the more it invests in quality improvements. This stems from the media firm attracting a larger audience, and thus becoming more attractive to the advertisers, the more it invests in quality improvements. It should be noted that this is partly due to the fact that a unilateral increase in Q_i improves the quality of that media firm, making media firm i relatively more attractive than media firm j. This implies that each firm has an incentive to invest in quality improvements in order to steal viewers from its competitor, and this business-stealing effect is stronger the closer substitutes the consumers perceive the media firms' products to

be. An increase in Q_i therefore has a larger positive impact on R_i and A_i the higher is b:

$$\frac{\partial^2 R_i}{\partial Q_i \partial b} = 2\frac{4+b^2+2b}{4-b^2} > 0, \text{ and } \frac{\partial^2 A_i}{\partial Q_i \partial b} = \frac{4b}{(4-b^2)^2} > 0. \tag{28}$$

In order to see how a unilateral quality improvement of media firm i affects the firm's revenues from user payment, we can use equations (10), (23), and (24) to find that

$$\frac{\partial V_i}{\partial Q_i} = \frac{4-3b^2}{2(4-b^2)(1-b)} > 0, \text{ and } \frac{\partial p_i}{\partial Q_i} = \frac{2-b^2}{(4-b^2)} > 0, \tag{29}$$

i.e., media firm i attracts a larger audience and is able to charge higher user payments the higher its quality. We further have

$$\frac{\partial^2 V_i}{\partial Q_i \partial b} = \frac{1}{2}\frac{16(1-b)+3b^4}{(1-b)^2(4-b^2)^2} > 0 \text{ and } \frac{\partial^2 p_i}{\partial Q_i \partial b} = -\frac{4b}{(4-b^2)^2} < 0. \tag{30}$$

Again, the business-stealing effect implies that the size of the audience for media firm i increases more due to a quality improvement the higher is b. This explains why $\partial^2 V_i/\partial Q_i \partial b > 0$. However, the price competition between the media firms is tougher the closer substitutes their products are. Therefore the price increase due to a quality improvement is decreasing in b, so that $\partial^2 p_i/\partial Q_i \partial b < 0$. Thus, the media firms are less able to charge the consumers for higher programming investments the higher is b, indicating that consumer payments as a source of revenue is less important the closer horizontal substitutes the media firms produce, also when Q is endogenous. To see this formally, we can make use of the symmetry of the equilibrium to write $R = R_1 = R_2$, $p = p_1 = p_2$, $A = A_1 = A_2$, $V = V_1 = V_2$, and $Q = Q_1 = Q_2$. Putting this into equations (22)-(25), we can express equilibrium prices and quantities in the following simple way:

$$R = \frac{1+b}{2+b}(1+Q), \; p = \frac{1-b}{2-b}(1+Q), \tag{31}$$

$$A = \frac{b^2}{2(4-b^2)}(1+Q), \text{ and } V = \frac{4+2b-b^2}{2(4-b^2)}(1+Q), \tag{32}$$

where Q is implicitly given by eq. (26). These expressions for prices and quantities are the same as in our previous analysis without quality investments, except that they are now multiplied by $(1+Q)$. This means that consumer revenue as share of

total revenue, $S(b)$, is independent of whether quality investments are endogenous or fixed at zero. We thus know from Section 3 that $S(0) = 1$ and $S'(b) < 0$.

We conclude:

Proposition 5: *In a stable and symmetric equilibrium, the media firms invest more in quality and raise a smaller share of their revenues from consumers the closer substitutes the media products are.*

6 Concluding remarks

The main purpose of this paper is to show that the tougher the competition between media firms is, the more important are advertising revenues likely to be. In order to show this, we set up a very simple model where a media firm, when it is a monopolist, maximizes profit by being financed purely by the audience, but where it ends up being purely financed by advertising when it faces competition from a media firm whose product is close to a perfect substitute. We further show that competition between media firms makes them invest more in quality, but that these investments do not change the way they are financed.

A crucial assumption behind our results is that the media firms compete in prices. Assuming price competition in the consumer market is hardly controversial, but it could be argued that it is more reasonable to assume that media firm compete in advertising *quantities* rather than in advertising prices. First, media firms can presumably relatively easily commit themselves with respect to how much space to allocate to commercials. Second, it may be argued that media firms *plan* in terms of quantities: how many pages of advertising should there be in a newspaper, and how often should a television program be interrupted by commercials (see Godes, *et al.*, 2003)? In practice, however, there are no physical limits to how much space media firms can use for advertising. Thus, the firms need to communicate possibly self-imposed quantity limits to the market. But what we typically observe is announcement of advertising prices only; it is rather uncommon to see that printed newspapers commit to a maximum number of pages with advertising, or that TV

channels commit to a maximum time for commercials per day.[8] Nor do we observe advertisers paying a lower price the more total advertising there is at a media firm, which could be an indirect way of committing to a "low" advertising volume. The advertising-price scheme is rather based on, for instance, the size of the audience and the number of minutes the commercial of a given advertiser is shown.

We have assumed that consumers pay a fixed price per viewing time on TV or per copy of a newspaper, which may be a reasonable approximation to the pricing schedule used on pay-TV and non-subscription newspapers, for instance. It should be noted, though, that many media firms have a fixed monthly or annual fee. An interesting extension of the model would be to consider alternative payment models in order to analyze the robustness of the result that advertising revenue tends to become more important for media firms the higher the competitive pressure.

Our model may be considered as a complement to research papers on media economics that build on the Hotelling framework. The advantage of the Hotelling framework is that it makes it possible to endogenize the extent of horizontal differentiation between the media products. However, a disadvantage is that the total number of consumers typically is given, such that aggregate output is independent of whether there is any competition. In our framework, competition leads to higher output, and we believe that this is a reasonable prediction both in the media industry and in other markets.[9]

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[8] However, in some European countries, there is an upper, regulatory limit on how much advertising there can be on TV; see Anderson (2004).

[9] For the same reason, we find that competition leads firms to invest more in quality, while the typical prediction in Hotelling models is that competition leads to less quality investments.

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8 Appendix

Second-order conditions and proof that $\frac{dQ}{db} > 0$*:*

The first-order condition for optimal quality investment by firm i is

$$\frac{\partial \pi_i}{\partial Q_i} = \frac{(8 - 4b + 8b^2 + 3b^3 + b^4) + (8 - 8b^2 + b^4)\, Q_i - b\,(4 - 3b^2)\, Q_j}{(1-b)\,(4-b^2)^2} - \phi'(Q_i) = 0,$$

$$i, j = 1, 2,\ i \neq j \quad (33)$$

Solving $\frac{\partial^2 \pi_i}{\partial Q_i^2} < 0$, we find that the second-order condition for an interior solution is satisfied if

$$\phi'' > \frac{8 - 8b^2 + b^4}{(1-b)(4-b^2)^2}. \quad (34)$$

A necessary condition for the system to be stable is that $\left|\frac{dQ_i}{dQ_j}\right| < 1, i \neq j$. Differentiation of (33) yields

$$\frac{dQ_i}{dQ_j} = \frac{b\,(4 - 3b^2)}{(8 - 8b^2 + b^4) - (1-b)\,(4-b^2)^2\,\phi''(Q_i)},\ i, j = 1, 2,\ i \neq j,$$

from which it follows that the stability condition requires

$$\phi'' > \hat{\phi} := \frac{(1+b)\,(8 - 4b - 4b^2 + b^3)}{(1-b)\,(4-b^2)^2}. \quad (35)$$

Comparing the critical values of ϕ'' in (34) and (35) verifies that the second-order condition holds if the system is stable.

To prove that quality investments are increasing in b, we first totally differentiate (33) with respect to Q_i, Q_j and b, and then set $dQ = dQ_i = dQ_j$, and $Q = Q_i = Q_j$. This implies that we in a symmetric equilibrium have

$$[\phi'' - B]\left.\frac{dQ}{db}\right|_Q = \frac{16 - 8b^3 - b^4}{(4-b^2)^3}\,(1 + Q)\,, \quad (36)$$

where $B := \frac{8+4b-4b^2-b^3}{(4-b^2)^2} < \hat{\phi}$, where $\hat{\phi}$ is defined in (35). Thus, stability implies that the square-bracketed term on the left-hand side of (36) is positive. Since the right-hand side of (36) is positive for all values of b, it follows that $\frac{dQ}{db} > 0$ if the stability condition is satisfied. *Q.E.D.*