Do Advertisers or Viewers Decide TV Channels'
Programming Choice?

by
Øystein Foros
Hans Jarle Kind
Guttorm Schjelderup

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Øystein Foros

Norwegian School of Economics and Business Administration.

oystein.foros@nhh.no

Hans Jarle Kind

Norwegian School of Economics and Business Administration.

hans.kind@nhh.no

Guttorm Schjelderup

Norwegian School of Economics and Business Administration.

guttorm.schjelderup@nhh.no

Abstract:

Ad-financed TV channels are two-sided platforms where media houses provide communication from advertisers to viewers. Most media houses air several channels, some of which are particularly valuable to advertisers. At first glance one might expect that the ad volumes are highest in the channels that are the advertisers' favorites. However, a crucial management challenge for media houses is to ensure that viewers go where the potential for raising advertising revenue is greatest. Since viewers dislike ads, we show that this implies that advertising volumes will be relatively low (and advertising prices relatively high) in the such channels. Indeed, other things equal, the ad-volume in a channel is inversely related to its attractiveness on the advertising market. Only if the costs of using alternative tools to attract viewers to the advertisers' favorite channels are sufficiently small, will the advertising volume in channels with high demand for ads be larger than in channels with low demand for ads.

Keywords: *advertising financed TV, program selection, programming investments.*

1 Introduction

Ad-financed television is a two-sided market where consumers select programs with their eyeballs, and media houses deliver eyeballs to advertisers. Advertisers and viewers thus interact through a platform (a media house) that accounts for the externalities between the two groups.[1] Empirical studies indicate that TV viewers dislike ads, while advertisers prefer a large audience. In this sense there is a negative externality from advertisers to viewers and a positive externality from viewers to advertisers. Being interrupted by commercial breaks might thus be considered as an implicit price that ad-averse viewers have to pay for watching TV. Consequently, it is not surprising to find that the variable fee for watching TV is typically zero, and that media houses make a large share of their revenue from the advertising side of the market.[2]

In general, advertisers go where TV viewers go. However, for a given number of viewers, some TV channels (program profiles) are valued more by the advertisers than others. One reason for this is that the sales-enhancing effect of an ad may vary between channels. "People cannot be coughing and dying right before a Lucky [Strike] ad" is the way Don Draper and his colleagues at the Sterling Cooper Advertising Agency put it (from the TV drama Mad Men, set in 1960s New York). In a similar vein, the value of advertising for a journey to South Africa is greater in a feel-good travel channel than in a news channel which discusses the wide-spread violence in the country.

Our main research question is: If a given media house airs more than one channel, and advertisers value some channels more than others, how should it set advertising prices and advertising volumes? Using insight from one-sided markets, one might

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[1] This feature of a two-sided market is also found in other ad-financed media markets, where the platform provider links the audience and the advertisers, such as newspapers, social networks (like Facebook), search engines (Google links advertisers and searchers). See e.g., Rysman (2009) and Parker and van Alstyne (2005) for more examples.

[2] The most common price structure in the TV market is one where the viewers pay a fixed fee for accessing a channel (or a bundle of channels) independent of actual viewing time. Pay-per-view TV still has a relatively small share of the market.

expect that the more attractive it is to advertise in a channel, the higher the channel's profit maximizing advertising volume will be. Taking the two-sidedness of the market into account, we show that the opposite may be true. A central management challenge for a multi-channel media house is to ensure that viewers go where the advertisers prefer them to go. We show that this implies that it is optimal to choose ad prices such that the ad volumes in the advertisers' favorite channels are reduced compared to channels with lower demand for ads. Other things equal, this tends to make the channels with the highest potential for raising advertising revenue more attractive for ad-averse viewers.

Multi-channel media firms may have alternative tools available, such as programming investments, to make viewers and advertisers prefer the same channels (the advertisers' favorites). However, unless the costs of using such alternative tools are sufficiently low, multi-channel media houses should use pricing strategies which ensure that ad volumes are lowest in the channels with the highest demand for ads. There is one important caveat here; if the viewers have a high willingness to shift from one channel to another (i.e., if the audience perceives the channels as close substitutes in terms of viewer utility), a given media house might find it optimal to close down the channel with the lower potential for raising advertising revenue.

Our qualitative results hold independent of whether the multi-channel media house faces competition from other media firms. Due to the two-sided nature of ad-financed TV, the opportunity cost of having a high advertising level is smaller at a channel with low demand for ads than at a channel with high demand for ads. It is consequently optimal for the media house, also under competition from other media houses, to charge a high advertising price and accept a low advertising volume at the advertisers' favorite channels. An observation that one channel has more ads than another, thus does not necessarily imply that this channel is particularly valuable for the advertisers. Actually, it could indicate that the channel faces a relatively low demand for ads.

2   Relevant Literature

Wilbur (2008), testing a discrete choice model using US data, provides important insights into the two-sided nature of ad-financed TV-channels and the interplay between advertising and viewing markets. He finds that viewers are strongly ad averse, and that a 10 % increase in advertising levels is likely to reduce audience size by about 25 % for a highly rated network (all other things equal). Previous studies also show that TV-viewers try to avoid advertising breaks, see e.g., Moriarty and Everett (1994) and Danaher (1995).[3] Hence, to obtain viewer demand estimates it is crucial to control for advertising levels. Wilbur further poses the question of whether it is the viewers or the advertisers that have the larger impact on TV channels' program selection. His study does not contain a theoretical model, but based on his empirical study he shows that the viewers' two most preferred program genres, Action and News, account for only 16% of network program hours, while Reality and Comedy, which are the advertisers' preferred genres, account for 47% of network program hours. More generally, his findings suggest that advertisers' preferences have stronger impact than viewers' preferences on media houses programming choices. This resembles the theoretical results in the present paper.

Our article is also closely related to the literature on two-sided markets. Seminal papers on the pricing in such markets are Rochet and Tirole (2003, 2006), Armstrong (2006), Caillaud and Jullien (2003), Economides and Katsamakes (2006), and Parker and van Alstyne (2005).[4] In general it is well known that prices in two-sided markets depend on the set of demand elasticities and marginal costs on both sides of the market (Rysman, 2009, Rochet and Tirole, 2003, 2006). This insight has important implications for the pricing strategy in media markets. A pioneering theoretical contribution to the two-sided nature of ad-financed media markets is provided by Anderson and Coate (2005), who analyze both advertising financed TV and pure

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[3]In other media markets consumers may not dislike ads. Kaiser and Wright (2006), for instance, show that readers of women's magazines appreciate ads. Rysman (2004) analyzes the market for yellow pages directories and he finds that consumers' utility increases with the number of pages with ads.

[4]Eisenmann et al. (2006) provide a guide to business strategies in two-sided markets.

pay-TV. Kind et al (2009) study how competitive forces influence the way media firms are financed. They find that a media firm's ability to finance content fully by ads is constrained by the number of competitors. Godes et al. (2009) analyze how competition between firms in different media industries, such as TV channels and newspapers, affects pricing strategies (see also Dukes and Gal-Or, 2003).[5] In the present paper we assume that the viewers can watch TV free of charge, since we focus on how media houses should react to the interplay between advertisers' and viewers' preferences for TV content.

3   The model

We consider a context where a media house operates two channels, $i = H, L$, that differ in their programming profiles. One of the channels might for instance be a sports channel and the other a film channel. The time spent watching channel i is denoted by V_i, and we follow Kind et al (2007, 2009) in assuming that the consumers' gross utility of watching TV is given by

$$U = (1 + Q_H) V_H + (1 + Q_L) V_L - \frac{1}{2} \left[4 (1 - s) \left(V_H^2 + V_L^2 \right) + s \left(V_H + V_L \right)^2 \right]. \quad (1)$$

where $Q_i \geq 0$ is the viewers' perceived quality of the programs offered by channel i. The channels are vertically differentiated if $Q_i > Q_j$, with channel i having the higher quality. The parameter $s \in [0, 1]$ is a measure of the extent of horizontal differentiation: the viewers consider the TV channels' programs as completely unrelated if $s = 0$, and as perfect horizontal substitutes if $s = 1$. More generally, the higher s, the closer substitutes are the channels from the viewers' point of view. Note that the viewers do not have preferences for one channel over the other if $Q_1 = Q_2$. Ceteris paribus, the consumers therefore prefer to use 50 % of their total viewing time on each channel.[6]

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[5] When advertisers' preferences have an impact on the quality, this obviously raise welfare issues. Anderson and Gabzewicz (2006) discuss how advertisers' preferences may distort the newspaper content away from the readers' preferences. We do not address welfare issues in the present paper.

[6] Utility function (1) is due to Shubik-Levitan (1980), and is a modification of the standard quadratic utility function. Under the standard quadratic utility function a change in the parameter

In most countries consumers pay e.g. a cable operator a fixed monthly fee (F) to get access to TV channels, which subsequently can be watched free of monetary charges. The focus of this paper is to analyze the implications of the fact that advertisers have a greater willingness to pay for ads in some types of programs than in others. For simplicity we therefore abstract from the distribution layer of the TV industry and set $F = 0$, but this does not affect the qualitative results at which we arrive.

Consistent with empirical data we assume that viewers have a disutility of being interrupted by commercials. We assume that viewers' subjective cost of watching channel i is $C_i = \gamma A_i V_i$, where A_i is the advertising level in the channel, and $\gamma > 0$ is a parameter that measures the viewers' disutility from advertising. This means that the consumer surplus from watching TV is given by

$$CS = U - \gamma(A_H V_H + A_L V_L). \tag{2}$$

Solving $V_i = \arg\max CS$ we find that the viewing time on each channel is given by

$$V_i = \frac{1}{2} + \frac{(2-s)(Q_i - \gamma A_i) - s(Q_j - \gamma A_j)}{4(1-s)}. \tag{3}$$

Each TV channel makes profits by selling advertising space. To simplify the exposition, but without affecting the general insights to follow, we assume that variable production costs in a TV channel are zero. In accordance with these assumptions, the profit function for the media house is

$$\Pi = R_H A_H + R_L A_L - \phi Q_H^2 - \phi Q_L^2 \qquad (\phi > 0), \tag{4}$$

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s would affect both the substitutability between the goods and the size of the market (see e.g., McGuire and Staelin, 1983). This is not the case with the Shubik-Levitan utility function, where s is a unique measure of channel substitutability. Our qualitative results would go through also with the standard quadratic utility function, but then an increase in s would both reduce the size of the market and increase the substitutability. This makes it more difficult to perform comparative statics. See Motta (2004) for a general discussion of the advantages of the Shubik-Levitan utility function over the standard quadratic utility function. Specific applications of the Shubik-Levitan utility function are for instance Shaffer (1991) and Foros, Hagen and Kind (2009).

where R_i is the price that the advertiser has to pay for an advertising slot on channel i. The term ϕQ_i^2 captures the channel's cost of investing in programming quality. In practise this could be the costs of buying programs which the audience finds attractive (like popular baseball matches or movies). For simplicity we treat this as a continues variable.

Let A_{ki} denote advertiser k's advertising level in channel i. It is reasonable to assume that the advertiser's gross gain from advertising is increasing in its advertising level and in the number of viewers. To make it simple we let the gross gain be equal to $\eta_i A_{ki} V_i$, where η_i is a positive constant - the larger η_i, the more attractive is channel i for the advertisers. This implies that the net gain for advertiser k from advertising on TV equals

$$\pi_k = \sum_i \left(\eta_i A_{ki} V_i - A_{ki} R_i \right), \ \ k = 1, .., n, \tag{5}$$

where n is the number of advertisers, and R_i is the price that the advertiser has to pay for an advertising slot on channel i.

Below, we consider a three-stage game. At stage 1, the media house determines advertising prices (R_i) and quality investments (Q_i). At stage 2 the advertisers choose how much advertising space to buy, and at stage 3 the consumers decide their viewing time on each channel. We solve the game by backward induction, and the solution to the final stage is given by equation (3).

At stage 2 we solve $\partial \pi_k / \partial A_{ki} = 0$, and find that advertiser k's demand for advertising on channel i as

$$\frac{\partial \pi_k}{\partial A_{ki}} = 0 => \qquad R_i = \eta_i V_i + \left[\eta_i A_{ki} \frac{\partial V_i}{\partial A_{ki}} + \eta_j A_{kj} \frac{\partial V_j}{\partial A_{ki}} \right]. \tag{6}$$

Abstracting from the terms in the bracket on the right-hand side of equation (6), we see that the willingness to pay for an ad on channel i is proportional to the size of the audience ($R_i \sim V_i$). However, a higher advertising level on channel i makes that channel less attractive for the TV viewers and the other channel more attractive. These effects are captured by the terms $\frac{\partial V_i}{\partial A_{ki}} = -\frac{(2-s)}{4(1-s)}\gamma < 0$ and $\frac{\partial V_i}{\partial A_{ki}} = \frac{s}{4(1-s)}\gamma > 0$.[7]

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[7]Note that the absolute value of these effects is increasing in s. This captures the fact that the

We shall assume that each advertiser is a price taker in the sense that he rationally disregards the possibility that his advertising volume has any effect on the attractiveness of the TV channels (meaning that the square bracket in (6) equals zero). This amounts to assuming that the number of advertisers (n) is infinitely large:

Assumption 1: *Let $n \to \infty$.*

Solving (6) and using (3) we find that aggregate demand for advertising at each channel equals

$$A_i = \frac{1}{\gamma} \left[1 + Q_i - (2 - s) \frac{R_i}{\eta_i} - s \frac{R_j}{\eta_j} \right].\tag{7}$$

Equation (7) shows that the demand curve for advertising is downward-sloping, $\partial A_i / \partial R_i < 0$, and more interestingly, that the demand for advertising on channel i is decreasing in channel j's advertising prices ($\partial A_i / \partial R_j < 0$). The reason is that viewers' dislike ads. Therefore, if the price of an ad slot (R_j) increases, the ad level on channel j falls making channel j more attractive to viewers. Channel i, on the other hand, ends up with a smaller audience and a lower demand for advertising.

In our model we have assumed that the viewers do not have preferences for one channel over the other. This assumption is made to bring forward as clearly as possible the advertisers' influence on the audience' allocation of viewing time across the two channels . To capture the fact that a certain type of program profile is more valuable to advertisers, we assume that channel H is preferred by advertisers in the sense that advertisers' gross gains from advertising on channel H are higher than on channel L, that is,

Assumption 2: $\eta_H > \eta_L$.

Not surprisingly, equation (7) makes it clear that advertising demand for channel i is increasing in η_i ($\partial A_i / \partial \eta_i > 0$) and decreasing in η_j ($\partial A_i / \partial \eta_j < 0$). We thus note:

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better substitutes the public perceives the channels to be, the more willing they are to shift from a channel with a high advertising level to a channel with a low advertising level.

Remark 1: *Other things equal, there is a larger demand for advertising in the H-channel than in the L-channel.*

3.1 Without quality investments

We start out by assuming that the media house cannot make any programming investments ($Q_H = Q_L = 0$). At stage 1 the media house thus solves $\{R_H, R_L\} = \arg\max \Pi$. The corresponding first-order condition is

$$\frac{\partial \Pi}{\partial R_i} = \left[A_i + R_i \frac{\partial A_i}{\partial R_i} \right] + R_j \frac{\partial A_j}{\partial R_i} = 0. \tag{8}$$

The term in the squared bracket on the right hand side depicts the usual change in marginal revenue following a change in the price R_i of advertising. A higher price increases the profit margin at channel i, but it also causes advertising sales for channel i to fall ($\partial A_i / \partial R_i < 0$). Non-standard is the last term on the right hand side. It exhibits how advertising demand for channel j responds to a rise in the ad price of channel i. From equation (7) it follows that the demand for ad slots on channel j falls when the price of ad slots on channel i rises, that is $\partial A_j / \partial R_i < 0$. This effect makes it clear that multi-channel media houses tend to set lower advertising prices than media houses which only operate one channel.

Solving (8) simultaneously for the two channels, and inserting for A_i from equation (7), we obtain the optimal price for ads in channel i as

$$R_i = \frac{(4 - 3s)\,\eta_i - \eta_j s}{N_1} \eta_i \eta_j, \tag{9}$$

where $N_1 > 0$ whenever the second-order conditions and non-negativity constraints hold (see the Appendix).

Combining (3), (7) and (9), assuming that both channels are aired, we have that

$$A_i = \frac{2(1-s)\left[4\eta_i - s\left(\eta_i - \eta_j\right)\right]\eta_j}{\gamma N_1} \text{ and } V_i = \frac{\left[(4-3s)\,\eta_i - \eta_j s\right]\eta_j}{N_1}. \tag{10}$$

Lessons from one-sided markets indicate that the more attractive it is to advertise on a channel, the more ads will it contain. In particular, one might expect that if

initially $\eta_H = \eta_L = \eta$, then a small increase in the attractiveness of channel H will increase the ad-volume of that channel. Rather surprisingly, the opposite is true:

Proposition 1: *If we start from the position that both channels are equally attractive to advertisers $(\eta_H = \eta_L = \eta)$, increasing the gross gain to advertisers of advertising on channel H leads the management of the multi-channel media house to reduce the ad volume of channel H and increase the ad volume of channel L;*

$$\left.\frac{\partial A_{iH}}{\partial \eta_H}\right|_{\eta_H=\eta_L=\eta} = -\frac{1}{16}\frac{s}{\eta} < 0 \text{ and } \left.\frac{\partial A_{iL}}{\partial \eta_H}\right|_{\eta_H=\eta_L=\eta} = \frac{1}{8}\frac{s}{\eta} > 0 \ .$$

Hence, if the gross gain from advertising on the high-value channel increases, the media house will reduce the amount of advertising on that channel and increase the amount of advertising on the other channel. The reason is that the media house thereby attracts more viewers to the H channel when the audience dislikes ads. Consistent with this result, we find from equation (10) that

$$A_H - A_L = -\left(\eta_H^2 - \eta_L^2\right)\frac{2s\left(1-s\right)}{\gamma N_1} < 0.$$

Even though by assumption demand for ads is higher for channel H than for channel L (c.f. Remark 1), it will thus have a lower advertising level.

Wilbur's finding that a 1 % reduction in a channel's ad level might increase the size of its audience with 2.5 % (see Wilbur, 2008) indicates that adjustment of ad levels could be an effective tool to attract viewers. A further gain for the media house of using this strategy is that it reallocates viewers from the channel where the advertisers have a low willingness to pay for ads to the channel where they have a high willingness to pay. Formally, using equations (9) and (10) we have:

$$
\begin{aligned}
R_H - R_L &= \left(\eta_H - \eta_L\right)\frac{2\eta_H\eta_L\left(2-s\right)}{N_1} > 0 \\[2mm]
V_H - V_L &= \frac{\left(\eta_H^2 - \eta_L^2\right)s}{N_1} > 0
\end{aligned}
\tag{11}
$$

Summing up, we have:

Proposition 2: *When the media house does not invest in program quality* $(Q_H = Q_L = 0)$, *and both channels are aired, the channel with the greater value for advertisers (channel H) has:*

(i) More viewers $(V_H > V_L)$

(ii) Higher advertising prices $(R_H > R_L)$

(iii) Lower advertising volume $(A_H < A_L)$.

Note that the closer substitutes the channels are from the audience's point of view, the more willing the viewers are to shift from one channel to the other. Since the H-channel is the most profitable one for the media house, it can be shown that it is optimal to close down the L-channel if the consumers perceive the channels to be close substitutes:

Corollary 1: *When* $Q_H = Q_L = 0$, *the low-value channel (L) will not be aired if the two channels are sufficiently close horizontal substitutes, that is, if*

$$s > s^{crit} \equiv \frac{4\eta_L}{n_H + 3\eta_L}$$

3.2 With quality investments

In this section the media house determines both the advertising price (R_i) and programming investments (Q_i) at stage 1. Compared to the previous section the media house now has an additional tool available to affect the absolute and relative attractiveness of the two channels. The game structure is the same as before, and the outcomes at stage 3 and stage 2 of the game are still given by (3) and (7), respectively.

Solving $\{R_i, Q_i\} = \arg\max \Pi$ at stage 1 we obtain the following first-order conditions for optimal ad prices and investment levels:

$$R_i = 2\eta_i\eta_j\gamma\phi\frac{2\gamma\left[\eta_i\left(4 - 3s\right) - \eta_j s\right]\phi - \eta_i\eta_j}{N_2} \tag{12}$$

and

$$Q_i = \eta_i\eta_j\frac{2\gamma\left[4\eta_i\left(1 - s\right) - s\left(\eta_j - \eta_i\right)\right]\phi - \eta_i\eta_j}{N_2}, \tag{13}$$

where $N_2 > 0$ (see the Appendix).

Inserting (12) and (13) in (3) and (7), we derive expressions for the ad levels and the size of the audiences as

$$A_i = 4\phi\eta_j \frac{2\gamma(1-s)\left[4\eta_i - s\left(\eta_i - \eta_j\right)\right]\phi - \eta_i\eta_j}{N_2} \tag{14}$$

$$V_i = 2\phi\eta_j\gamma \frac{2\gamma\left[\eta_i(4-3s) - \eta_j s\right]\phi - \eta_i\eta_j}{N_2}. \tag{15}$$

Note that advertisers do not care about the channels' quality levels *per se*. However, other things equal, the higher a channel's quality level, the more viewers it attracts, and the larger the demand for advertising. Since the media house's incentives to make quality investments are positively related to the advertisers' willingness to pay for an ad, we find from the first-order conditions that the H-channel has a higher quality level than the L-channel:

$$Q_H - Q_L = \frac{4\eta_H\eta_L\phi\gamma(\eta_H - \eta_L)(2-s)}{N_2} > 0.$$

Using the conditions above, we can show that the advertising price and the number of viewers are higher for the H-channel than for the $L-$channel, that is, $R_H - R_L > 0$ and $V_H - V_L > 0$. This result is similar to what we found when the media house could not invest in program quality (confer Proposition 2 for $s > 0$). However, the costs of quality investments determine which channel that will have the higher ad volume:

Proposition 3: *When the media house invests in program quality and both channels are aired, the channel with the greater value for advertisers (channel H) has:*

(i) More viewers $(V_H > V_L)$

(ii) Higher advertising prices $(R_H > R_L)$

(iii) Lower advertising volume $(A_H < A_L)$ if $\phi > \phi^* \equiv \eta_H\eta_L/2s(1-s)\gamma(\eta_H + \eta_L)$.

Proposition 3 makes it clear that when the media house can use both ad levels and quality investments to enhance the attractiveness of a channel, both instruments are

used in favor of the channel that is valued the most by the advertisers. Advertisers, therefore, implicitly determine investments in program quality as well as the level of ads in the two channels. At the heart of this strategy is the insight that it is crucial for a media house to make viewers and advertisers prefer the same channel.

In the Appendix we prove part (iii) of Proposition 3, which shows that the media house will undertake programming investments such that the advertising level at channel H is higher than at channel L if $\phi < \phi^*$. The relationship between investment costs and advertising levels is illustrated in Figure 1, where we have assumed that $\eta_H = 1.5$, $\eta_L = 1.0$ and $s = 0.5$. The figure shows that the advertising volume at the H-channel is higher than at the L-channel if and only if investment costs are sufficiently small ($\phi < \phi^* \approx 1.2$). Otherwise, the channel which is preferred by the advertisers has the lower advertising volume.
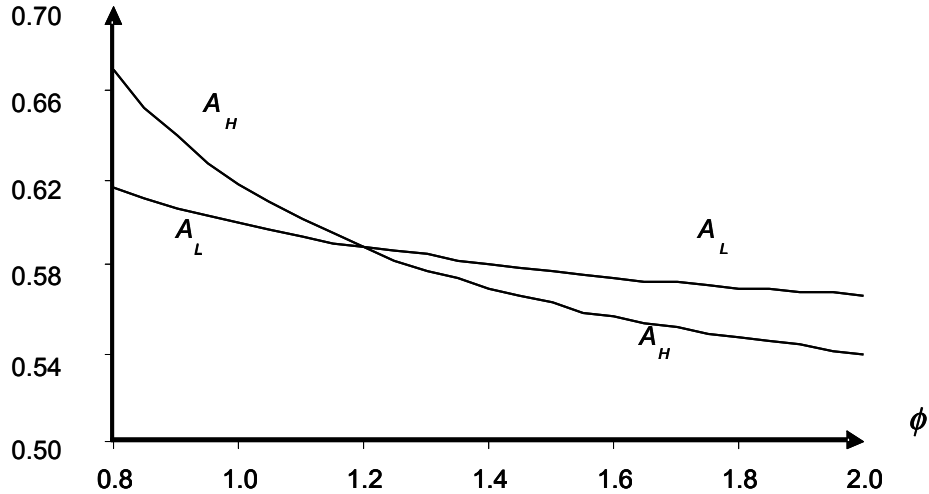
Figure 1: *Advertising levels with investments.*

Recall that in absence of quality investments, we found that if the audience perceives the TV channels to be sufficiently close horizontal substitutes ($s > s_{inv}^{crit}$), the media house would close down the low-value channel. In the present case we have:

Corollary 2: *With quality investments, the low-value channel will not be aired if the two channels are sufficiently close horizontal substitutes, that is, if*

$$s > s_{inv}^{crit} \equiv s^{crit} - \frac{\eta_L n_H}{2\gamma\phi\left(n_H + 3\eta_L\right)}$$

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Other things equal, the number of viewers will be smaller with one than with two channels. However, the more the media house invests in programming quality for the H-channel, the fewer viewers it loses by closing down channel L. Therefore, it is profitable for the media house to close down the low-value channel even if the other channel is a relatively poor substitute. On the expenditure side, it should be noted that this tends to reduce the media-house' total investment costs.

4   Extension: Competition among media houses

Above we have demonstrated that a manager of a media house which runs at least two channels should sell the lowest volume of advertising space on the channel with the highest advertising demand, other things equal. This is due to the two-sided nature of the TV-industry. So far we have only analyzed the case where the media house faces no competition from other TV channels. However, the qualitative results survive also with competition, and independent of whether competing media houses control one or several channels. This is clear since the first-order conditions for optimal advertising prices derived above (equation (8)) do not hinge on the media house being in a monopoly situation. In particular, consider an arbitrary media house k which runs one $H-$channel and one $L-$channel. Even if the media house faces competition, we still have that $\frac{\partial \Pi_k}{\partial R_{ki}} = 0$ implies

$$A_{ki} + R_{ki}\frac{\partial A_{ki}}{\partial R_{ki}} + R_{kj}\frac{\partial A_{kj}}{\partial R_{ki}} = 0. \ (i,j = H, L; \ i \neq j).$$

where the third term on the left-hand side is negative; $R_{kj}\frac{\partial A_{kj}}{\partial R_{ki}} < 0$.

Recall from equation (8) that the sign of this term reflects the fact that a higher advertising price at channel i reduces the advertising volume in that channel, and thus shifts viewers from channel j to channel i. Thereby advertising demand for the j-channel falls. Important in this respect is that the higher the willingness to pay for an ad on the j-channel is, the greater the subsequent loss will be for the media house. The opportunity cost of setting a high price for advertising is thus smaller at the H-channel than at the L-channel. It is consequently optimal for the media

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house, also under competition, to charge a high advertising price and accept a low advertising volume at channel H.

In the appendix we provide an illustration of this through an example where we have two media houses, each controlling one H-channel and one $L-$channel (this symmetry is chosen only to simplify the algebra). Otherwise, the model is the same as in Section 2. We then show the following:

Proposition 4: *Assume competition between two media houses, each having one H-channel and one L-channel. The channel with the greater value for advertisers (channel H) has the lower advertising volume if*

$$\phi > \phi^{**} = \frac{(2-s)\,\eta_H\eta_L}{4\gamma s\,(1-s)\,(\eta_H + \eta_L)}.$$

Independent of whether we have competition, we thus cannot infer that channels with high advertising levels are particularly valuable to advertisers. On the contrary, the opposite may be true. What we should expect, though, is that programming investments are higher the more attractive a channel is to the advertisers (even though the advertisers do not care about programming quality *per se*). In this sense it is advertiser preferences rather than viewer preferences which determine broadcasters' quality levels.

5   Some concluding remarks

Television absorbs a quarter of all advertising expenditures in the US. Given the fact that the average American spends over four and a half hours a day watching television, the scope for profit among advertisers and media houses is vast. The business model of media houses must take into account the externalities that arise between advertisers and viewers, and this yields some paradoxical results compared to what one might expect using insight from one-sided markets.

The driving force behind our results is that multi-channel media houses must try to transfer viewers from channels where demand for ads is low to channels where demand for ads is high. As a consequence, media houses will choose e.g. advertising

levels and investments in programming quality so as to make the viewers watch the advertisers' preferred channels. Our results thus fit well with recent empirical evidence by Wilbur (2008), who, based on US ad-financed television, finds that advertisers have a stronger impact than viewers on networks' program selection. A question for future research, then, is how this will influence the TV industry's business models in the future. In particular, technological changes have significantly increased the scope for charging the consumers directly for watching TV. With viewers' preferences being muted in advertising-financed networks, this should give rise to a competitive advantage for channels financed by a pay-per-view business model. Such alternative business models may lead TV channels to respond better to the program selection preferred by the viewers and to their willingness to pay for quality.

6   Appendix

6.1   Without quality investments

Proof that $N_1 > 0$ in the relevant area

Solving $\{R_H, R_L\} = \arg\max \Pi$ we find equations (9) and (10), where $N_1 \equiv 16\eta_H\eta_L (1 - s) - s^2 (\eta_H - \eta_L)^2$. Differentiation of N_1 yields

$$\frac{dN_1}{d\eta_H} = 16\eta_L (1 - s) - 2s^2 (\eta_H - \eta_L),$$

which means that the denominator N_1 is decreasing in η_H of $\eta_H > \eta_L$. From (10) we find that $V_L = 0$ for $\eta_H \geq \frac{4-3s}{s}\eta_L$. Since $N_1|_{\eta_H = \frac{4-3s}{s}\eta_L} = 16\eta_L^2 (1 - s) (2 - s)^2 /s > 0$, it follows that N_1 is positive in the relevant area. Q.E.D.

6.2   With quality investments

Proof that $N_2 > 0$ in the relevant area

Solving $\{R_i, Q_i\} = \arg\max \Pi$ we find (12) and (13), where

$$N_2 \equiv 4\gamma^2 \left(16\eta_H\eta_L (1 - s) - s^2 (\eta_H - \eta_L)^2\right) \phi^2 - 4\gamma\eta_H\eta_L (\eta_H + \eta_L) (2 - s) \phi + \eta_H^2\eta_L^2$$

The second-order conditions require that $H_1 \equiv -2\phi < 0$, $H_2 \equiv 4\phi^2 > 0$, $H_{3i} \equiv -2\phi \frac{4\phi\gamma(2-s)-\eta_j}{\gamma^2\eta_j} < 0$ and $H_4 \equiv \frac{N_2}{\eta_H^2\eta_L^2\gamma^4} > 0$. Note that $H_{3i} < 0$ if $\eta_j < 4\phi\gamma(2-s)$; using equation it can be shown that a higher value of η_j makes $V_i < 0$. H_{3i} is thus negative if both channels have non-negative audiences. Moreover, the Hessians H_1, H_2 and H_4 clearly have the required signs whenever $\phi > 0$ and $N_2 > 0$. $Q.E.D.$

Proof that $V_H > V_L$ and $R_H > R_L$

From (15) and (12) we find that

$$
V_H - V_L = \frac{2\phi\gamma\left[2\phi\gamma s\left(\eta_H + \eta_L\right) + \eta_H\eta_L\right]\left(\eta_H - \eta_L\right)}{N_2} > 0 \text{ and}
$$

$$
R_H - R_L = \frac{8\eta_H\eta_L\phi^2\gamma^2\left(2-s\right)\left(\eta_H - \eta_L\right)}{N_2} > 0,
$$

such that the size of the audience and the advertising price is higher for the H-channel than for the L-channel also with quality investments. $Q.E.D.$

Proof of part (iii) of Proposition 3:

From (14) we find

$$
A_H - A_L = \frac{4\phi\left(\eta_H - \eta_L\right)\left[\eta_H\eta_L - 2\gamma s\left(1-s\right)\left(\eta_H + \eta_L\right)\phi\right]}{N_2},
$$

which means that $A_L > A_H$ if and only if $\phi = \frac{\eta_H\eta_L}{2s(1-s)\gamma(\eta_H+\eta_L)}$. Note that this is equivalent to stating that $A_L > A_H$ if

$$
\frac{1}{2}\left(1 - \sqrt{\frac{\phi\gamma\left(\eta_H + \eta_L\right) - 2\eta_H\eta_L}{\phi\gamma\left(\eta_H + \eta_L\right)}}\right) < s < \frac{1}{2}\left(1 + \sqrt{\frac{\phi\gamma\left(\eta_H + \eta_L\right) - 2\eta_H\eta_L}{\phi\gamma\left(\eta_H + \eta_L\right)}}\right).
$$

It is thus for sufficiently high values of ϕ and "intermediate values" of s that the advertising level might be higher for the L-channel than for the $H-$channel. $Q.E.D.$

Profits are then strictly increasing in s

Inserting for equilibrium advertising prices and quality investments into the media house' profit function when both channels are operative, we find that

$$
\Pi = 2\eta_H\eta_L\phi\frac{4\phi\gamma\left(1-s\right)\left(\eta_H + \eta_L\right) - \eta_H\eta_L}{N_2}.
$$

We thus have

16

$$\frac{\partial \Pi}{\partial s} = \frac{16\phi^3\gamma^2\eta_H\eta_L\left(2-s\right)\left[2s\gamma\phi\left(\eta_H+\eta_L\right)+\eta_H\eta_L\right]}{N_2^2}\left(\eta_H-\eta_L\right)^2 > 0,$$

which makes it clear that aggregate profits are increasing in s unless $\eta_H = \eta_L$. It is further straight forward to show that aggregate profits are increasing in s if only one channel is operative (independent of whether η_H is greater than η_L). *Q.E.D.*

6.3 Competition among media houses

Proof of Proposition 4:

With two media houses running each their H-channel and L-channel we must modify (1) to

$$U = \sum_{i=1}^{2}\left[(1+Q_{iH})V_{iH}+(1+Q_{iL})V_{iL}\right]-2\left((1-s)\sum_{i=1}^{2}\left(V_{iH}^2+V_{iL}^2\right)+\frac{s}{4}\sum_{i=1}^{2}\left(V_{iH}+V_{iL}\right)^2\right).$$

This implies that

$$V_{1H} = \frac{1}{4}+\frac{(4-s)\left(Q_{1H}-\gamma A_{1H}\right)-s\left(Q_{1L}-\gamma A_{1L}+Q_{2H}-\gamma A_{2H}+Q_{2L}-\gamma A_{2L}\right)}{16\left(1-s\right)},$$

with similar expressions for V_{1L}, V_{2H} and V_{2L}. Thereby demand for ads equals

$$A_{1H} = \frac{1}{\gamma}\left[1+Q_{1H}-(4-3s)\frac{R_{1H}}{\eta_H}-s\left(\frac{R_{1L}}{\eta_L}+\frac{R_{2H}}{\eta_H}+\frac{R_{2L}}{\eta_L}\right)\right],$$

with similar expressions for A_{1L}, A_{2H} and A_{2L}

Maximizing profits for the two media houses with respect to advertising levels and quality investments we find a symmetric equilibrium. Omitting subscripts for each media house, we have (with $j = H, L$)

$$Q_j = \frac{2\phi\gamma\left[(8-7s)\eta_j-s\eta_{-j}\right]-\eta_j\eta_{-j}}{N_3}\eta_j\eta_{-j}, \text{ and } R_j = 2\phi\frac{2\phi\gamma\left[(8-7s)\eta_j-s\eta_{-j}\right]-\eta_j\eta_{-j}}{N_3}\eta_j\eta_{-j}\gamma,$$

where

$$N_3 = 8\gamma^2\left[8\eta_H\eta_L\left(1-s\right)\left(4-s\right)-s^2\left(\eta_H-\eta_L\right)^2\right]\phi^2-2\gamma\eta_H\eta_L\left(8-5s\right)\left(\eta_H+\eta_L\right)\phi+\eta_H^2\eta_L^2.$$

Advertising levels are then given by

$$A_j = 4\phi\eta_{-j}\frac{4\gamma\left(1-s\right)\left[\eta_j\left(8-5s\right)+s\eta_{-j}\right]\phi-\eta_j\eta_{-j}\left(2-s\right)}{N_3},$$

which in turn implies that

$$A_H - A_L = -4\phi \left(\eta_H - \eta_L \right) \frac{4\gamma s\phi \left(1 - s \right) \left(\eta_H + \eta_L \right) - \eta_H \eta_L \left(2 - s \right)}{N_3},$$

such that $A_L > A_H$ if $\phi > \phi^{**} = \frac{(2-s)\eta_H\eta_L}{4\gamma s(1-s)(\eta_H+\eta_L)}.Q.E.D.$

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