Advertising on TV: Under- or Overprovision?*

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Abstract

We consider a media model where TV channels transmit advertising and viewers dislike such commercials. Contrary to what might be a common belief, it turns out that the more consumers dislike ads, the more likely it is that welfare is increasing in the number of advertising financed TV channels. We further show that there is underprovision of advertising relative to social optimum if TV channels are sufficiently close substitutes. In such a situation, a merger between TV channels may lead to more advertising and thus improved welfare. A publicly owned TV channel can partly correct market distortions, in some cases by having a larger amount of advertising than a private TV channel. It may actually have advertising even in cases where it is wasteful *per se*.

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1 Introduction

The TV industry is important both in terms of the time people spend watching TV and the amount of advertising it transmits.[1] However, the key role played by advertising-financed channels in many countries' TV industries is potentially a mixed blessing. On the one hand, TV commercials may be the most efficient way for firms to advertise their products and can generate a surplus both for individual firms and for society as a whole. On the other hand, viewers dislike being interrupted by commercials.[2] We thus have an ambiguity that raises the questions of whether there is over- or underprovision of advertising on TV and of whether there is a need for some kind of public intervention in the sector.

In this paper, we set out to provide answers to these questions with the help of a simple model in which TV stations sell advertising space to advertisers. The basis for the advertisers' willingness to pay for such advertising space is the attention of the TV viewers that the stations attract. And in order to attract viewers, the stations offer TV programs. Thus, the TV industry is an example of a two-sided market; TV stations offer programs to viewers and advertising space to advertisers, with externalities in both directions.[3]

Obviously, the extent to which viewers dislike advertising on TV is an important factor in determining whether there is too much or too little advertising in equilibrium. In our analysis, we focus on another crucial factor which is perhaps less obvious: the degree of product differentiation between TV channels. If TV stations' program contents are similar, then a viewer's choice of TV station will be mainly driven by the amount of advertising on each station. This implies that the amount of advertising will be low, since each TV channel will have strong incentives to attract viewers from its rival by having relatively few commercials. Accordingly, we find that there is too little advertising on TV when the channels are close substitutes.

Early discussions of the welfare effects of advertising, such as Dixit and Norman (1978) and Becker and Murphy (1993), did not take into account the role of media firms as transmitters of advertising.[4] In Spence and Owen's (1977) discussion of advertising-financed TV vs. pay TV, the presence of advertising is assumed to have no effect on viewers. Wildman and Owen (1985) extend the Spence-Owen model to take into account that commercials are a nuisance to TV viewers. In this respect our model

[1]In 1995, the average adult male American spent 17.3 hours watching TV each week (Robinson and Godbey, 1999). In 2002, TV advertising in the US amounted to approximately USD 50 billion, out of a total of approximately USD 115 billion spent on advertising (see *Advertising Age,* http://www.adage.com/images/random/lna03.pdf).

[2]It is documented that viewers try to avoid advertising breaks, see for example Moriarty and Everett (1994) and Danaher (1995). See also Wilbur (2005), who estimates a model of TV competition and finds viewers' disutility from advertising to be significant and positive.

[3]To be precise, advertisers incur negative externalities on viewers, while viewers incur positive externalities on advertisers. For general introductions to the theory of two-sided markets, see Armstrong (2005a) and Rochet and Tirole (2005).

[4]For a survey of the economics literature on advertising, see Bagwell (2005).

is in the same spirit as theirs. There are some important differences, though. First, the Wildman-Owen model is one of monopolistic competition. In contrast, we model strategic interactions between TV stations in both a duopoly and oligopoly setting. Secondly, in the Wildman-Owen model the price of commercials is exogenously determined. An important contribution in our model, on the other hand, is to let the price of commercials be endogenously determined in a framework where TV stations compete both for viewers and advertising revenue. We find that this is important for understanding strategic interaction in media markets. For example, we show that tougher competition caused by greater substitutability between TV channels leads to higher advertising prices, while tougher competition caused by entry of new TV channels leads to lower advertising prices.

In recent analyses of the media market, such as Gabszewicz, *et al.* (2004), Anderson and Gabszewicz (2005), and Peitz and Valletti (2005), viewers are located along a Hotelling (1929) line, varying according to their preferences for TV-program content, and TV channels choose positions on that line.[5] Thereby product differentiation is endogenously determined. But this comes at a cost: First, a Hotelling analysis fixes the total size of the market (*i.e.*, the total amount of TV viewing). Secondly, each viewer is assumed to watch one channel only. We choose a different angle and fix the degree of product differentiation. This allows a framework in which the time people use watching TV is endogenous, depending on the extent of competition. As in most other markets – whether they are one-sided or two-sided – our model features the appealing property that stronger competition leads to higher output, *i.e.*, to people spending more time watching TV. Moreover, our formulation allows a viewer to allocate his time between different channels. This increases the competition in the market for advertising space, as each TV channel can offer advertisers a bit of any viewer's attention.

A final advantage of our framework is that we are able to deal with an arbitrary number of TV channels. This is particularly interesting since most democratic countries have reduced or eliminated public entry barriers for TV channels over the last decades. A major insight from our analysis is that a larger number of advertising-financed TV channels is more likely to have positive welfare effects the higher is the consumers' disutility from advertising. The intuition for this somewhat paradoxical result is that more competition, in the sense of an inflow of new TV channels, forces the existing channels to reduce their amount of utility-reducing advertising, and the positive welfare effects of less advertising are greater the more the consumers dislike advertising, other things equal.

Apart from partly or completely eliminating entry barriers, it is noteworthy that different countries have chosen distinctly different public-policy measures towards the

[5] See also the work by Anderson and Coate (2005), who do a welfare analysis in such a Hotelling-style setting. Other contributions in the recent literature on the economic analysis of media industries include Nilssen and Sørgard (2003), Gal-Or and Dukes (2003), Dukes (2004), Armstrong (2005a), and Crampes, *et al.* (2005). The seminal work is Steiner (1952); for a review of the early literature, see Owen and Wildman (1992). The more recent literature is reviewed by Anderson and Gabszewicz (2005).

TV industry. For instance, some countries have publicly owned TV channels and restrictions on the amount of advertising on TV, while other countries do not intervene in the market at all.[6] The potential for underprovision of advertising suggests that restrictions on the amount of advertising can be misguided. In particular, this is likely to be true if the TV channels are close substitutes.

In many European countries there are mixed oligopolies in the TV industry with both publicly and privately owned TV channels.[7] The government can partly correct for the distortions in the market for advertising by having a public TV channel compete with a privately owned TV channel. We show that, for sufficiently differentiated TV channels, the public TV channel sells less advertising space than the private channel, thereby partly correcting for the overprovision of advertisements in a system with only privately owned TV channels. Conversely, the public TV channel should advertise more than the private one if the TV channels are sufficiently close substitutes. In fact, we find that a welfare-maximizing public TV channel advertises even in some cases where advertising is *per se* wasteful (*i.e.*, where the disutility of viewers exceeds the surplus that the advertising generates for the advertisers).

This article is organized as follows. The formal model is presented in the next section, and in Section 3 we derive the equilibrium outcomes. In Section 4 we find social optimum, and in Section 5 we compare market equilibrium and social optimum. In Section 6 we analyze the consequences of having a welfare-maximizing TV channel that is owned by the government. In Section 7 we extend the equilibrium analysis of Section 3 to an m-channel oligopoly. Finally, we offer some concluding remarks in Section 8.

2 The model

There are two TV stations, channel 1 and channel 2, and a continuum of identical viewers with measure one. The time that each viewer spends watching TV programs on channel $i = 1, 2$ is denoted by V_i. We follow Motta (2004) and assume that consumers' preferences are given by the Shubik-Levitan utility function, originally introduced by Shubik and Levitan (1980):

$$U = V_1 + V_2 - \left[(1-s)\left(V_1^2 + V_2^2\right) + \frac{s}{2}\left(V_1 + V_2\right)^2\right]. \tag{1}$$

[6] The EU restricts TV advertising to 9 minutes on average, with a maximum of 12 minutes in any given hour, while some of the member states have stricter limits. See details in Anderson (2005) and Motta and Polo (1997). In the US, the National Association of Broadcasters at one time set an upper limit. In 1981, this was found to violate antitrust laws (see Owen and Wildman, 1992, ch. 5, and Hull, 1990). No restrictions (except for advertising on children's programs) exist in the US today.

[7] See Motta and Polo (1997) for a survey of the media industry in Europe. See Armstrong (2005b) and Armstrong and Weeds (2005) for some recent discussions on public service broadcasting.

We may interpret V_i both as the time that each viewer spends watching channel i and as the number of viewers at channel i, since we have normalized the population size to 1. The parameter $s \in [0, 1)$ is a measure of product differentiation: The higher is s, the closer substitutes are the two TV channels from the viewers' point of view. As will be clear below, the Shubik-Levitan formulation ensures that the parameter s only captures product differentiation and has no effect on market size.[8] This utility function is, moreover, straightforward to extend to an arbitrary number of TV channels (see Section 7).

We consider TV channels that are financed by advertising and that viewers can watch free of charge. However, viewers have a disutility of being interrupted by commercials. To capture this, we assume that viewers' subjective cost of watching channel i is $C_i = \gamma A_i V_i$, where A_i is the level of advertising per time unit and $\gamma > 0$ is a parameter that measures the viewers' disutility from advertising. A viewer's consumer surplus is thus given by

$$CS = U - \gamma(A_1 V_1 + A_2 V_2).$$

Setting $\frac{dCS}{dV_i} = 0$, we find that optimal viewer behavior implies

$$V_i = \frac{1}{2} - \frac{\gamma}{4} \frac{(2-s) A_i - s A_j}{1-s}, \ i = 1, 2. \tag{2}$$

Defining $V \equiv V_1 + V_2$ and $A \equiv A_1 + A_2$, we see from equation (2) that

$$V = 1 - \frac{\gamma}{2} A. \tag{3}$$

The total time viewers spend on the two TV channels is thus strictly decreasing in the aggregate advertising level and in the viewers' disutility from advertising. Equation (3) further makes it clear that the size of the market – measured in terms of TV viewers or time spent watching TV programs – is independent of s for any given level of total advertising A.

TV channel i charges the price R_i per advertising slot. Disregarding any production costs, we put the profit of channel i equal to

$$\Pi_i = R_i A_i, \ i = 1, 2. \tag{4}$$

Let A_{ik} denote advertiser k's advertising level on channel i. The advertiser's gross gain from advertising at channel i is naturally increasing in its advertising level and in the number of viewers exposed to its advertising. We make it simple by assuming that the gross gain equals $A_{ik} V_i$. This implies that the net gain for advertiser k from

[8] Note that this is in contrast to the standard quadratic utility function, where one and the same parameter measures both product differentiation and market size. See Motta (2004) for details.

advertising on TV equals

$$\pi_k = (A_{1k}V_1 + A_{2k}V_2) - (A_{1k}R_1 + A_{2k}R_2), \; k = 1, .., n, \tag{5}$$

where n is the number of advertisers. With a slight abuse of terminology, we label π_k the profit of advertiser k. The advertisers' aggregate profit equals $\pi_A \equiv \sum_{k=1}^{n} \pi_k$.

Most of the analyses in the literature consider the advertisers to be price takers and find the demand for advertising by way of a zero-profit condition on the marginal advertiser's profit.[9] We find it useful to do this differently, and more in line with models of successive oligopoly, such as Salinger (1988), where producers and retailers set quantities sequentially. We consider the following two-stage game:

Stage 1: TV channels set advertising levels.

Stage 2: The advertisers choose amounts of advertising to buy.

One noteworthy feature of our set-up is that the TV channels are quantity setters in advertising. If program choice is inflexible in the short run – with a given amount of time between each program – such an assumption is plausible. However, there might be arguments indicating that TV channels are more flexible concerning the amount of advertising.[10] If so, price setting on advertising is a more natural choice. It can be shown that our main results still hold if we assume price rather than quantity setting among TV channels.[11]

Unless stated otherwise, we assume that the TV channels act non-cooperatively.

3 Equilibrium outcomes

We solve the game by backward induction. At stage 2, the advertisers simultaneously determine how much to advertise on the two channels, taking advertising prices as given. Solving $\frac{\partial \pi_k}{\partial A_{1k}} = \frac{\partial \pi_k}{\partial A_{2k}} = 0$ simultaneously for the n advertisers and then using $A_i = \sum_{k=1}^{n} A_{ik}$, we find that demand for advertising at channel i equals

$$A_i = \frac{1}{\gamma}\left(\frac{n}{n+1}\right)\left[1 - (2-s)R_i - sR_j\right], \qquad i, j = 1, 2, \quad i \neq j. \tag{6}$$

As expected, we thus have a downward-sloping demand curve for advertising ($\frac{dA_i}{dR_i} < 0$). More interestingly, we see that demand for advertising on each channel is decreasing

[9] An exception is Gal-Or and Dukes (2003), who model pairwise negotiations between TV channels and advertisers.

[10] When transmitting newscasts or sport events, the TV channel is quite flexible in its choice of the amount of advertising. Moreover, to accommodate a small amount of advertising a TV channel can fill in with advertising for its own programs ('tune-ins'). For details concerning tune-ins, see Shachar and Anand (1998).

[11] Barros *et al.* (2004) formulate a model where media firms set prices of advertising rather than quantities. The equilibrium outcomes they find are analogous to the ones we report here. For a more detailed discussion of price versus quantity competition in the market for TV advertising, see Nilssen and Sørgard (2003).

also in the other channel's advertising price ($\frac{dA_i}{dR_j} < 0$). This follows from advertising on the two channels being complementary goods when viewers dislike advertising. To see why, suppose that R_j increases, so that the advertising level on channel j falls. This channel thereby becomes more attractive for the viewers, while channel i becomes relatively less attractive. The latter in turn means that channel i will have a smaller audience, which translates into a lower demand for advertising.

Using (6), we can write the inverse aggregate demand curve for advertising on channel i as

$$R_i = \frac{1}{2} - \frac{\gamma}{4}\left(\frac{n+1}{n}\right)\frac{(2-s)\,A_i - sA_j}{1-s}. \tag{7}$$

Note that

$$\frac{dR_i}{ds} = -\frac{\gamma}{4}\left(\frac{n+1}{n}\right)\frac{A_i - A_j}{(1-s)^2}.$$

This means that the marginal willingness to pay for advertising on channel i is increasing in s if and only if the advertising level on that channel is lower than on the other channel ($A_i < A_j$). This reflects the observation that the less differentiated the TV programs, the more prone viewers are to shift from a channel with much advertising to a channel with little advertising.

The TV channels set their advertising levels non-cooperatively at stage 1. (For collusion, see below.) Solving $\frac{d\Pi_i}{dA_i} = 0$, $i = 1, 2$, subject to (7), we find that the equilibrium advertising level at each TV channel equals

$$A_i^M = \frac{2}{\gamma}\left(\frac{n}{n+1}\right)\frac{1-s}{4-3s}, \tag{8}$$

where the superscript M denotes market equilibrium. The advertising level is thus decreasing in the viewer disutility of advertising (γ), which is quite natural.[12] We further see that $\frac{dA_i^M}{ds} < 0$, which means that the equilibrium advertising level is lower the less differentiated the TV channels. To understand this result, note that a TV channel attracts viewers by limiting the amount of advertising. The better substitutes the viewers perceive the two TV channels to be, the more sensitive they are to differences in levels of advertising. A high s thus gives each TV channel an incentive to set a relatively low advertising level in order to capture viewers from the other channel. The lower advertising level in turn allows each channel to charge a higher slotting price R_i^M and a higher contact price per viewer, $r_i^M \equiv \frac{R_i^M}{V_i^M}$:

$$R_i^M = \frac{2-s}{2\,(4-3s)},\ \frac{dR_i^M}{ds} > 0; \text{ and } r_i^M = \frac{(2-s)\,(n+1)}{4-3s+(2-s)\,n},\ \frac{dr_i^M}{ds} > 0;\ i = 1, 2. \tag{9}$$

Note also that $\frac{dA_i^M}{dn} > 0$. An increase in the number of advertisers thus increases the

[12] See also Anderson and Coate (2005).

demand for advertising. It is then optimal for the TV channels to offer more advertising space. We have:

Proposition 1 *Non-cooperative equilibrium levels of advertising on TV are smaller (i) the less differentiated the TV channels' programs are perceived to be; (ii) the higher the viewers' disutility of advertising; and (iii) the lower the number of advertisers.*

Inserting for A_i^M in (8) into the expressions for profit in (4) and (5), we find the equilibrium profit levels of TV stations and advertisers:

$$\Pi_i^M = \frac{1}{\gamma}\left(\frac{n}{n+1}\right)\frac{(1-s)(2-s)}{(4-3s)^2}, \text{ and } \pi_k^M = \frac{1}{\gamma}\frac{4}{(n+1)^2}\frac{(1-s)^2}{(4-3s)^2}, \ i=1,2, \ k=1,...,n. \tag{10}$$

We see that profits are decreasing in both γ and s. Higher disutility for consumers from watching advertising leads to less advertising, which is disadvantageous for both TV channels and advertisers. A higher s will, as explained above, lead to less advertising, and again, both TV channels and advertisers are worse off. It can further be verified from (10) that an increase in the number of advertisers leads to higher profits for the TV channels, but lower profits for the advertisers. This is due to the fact that the market power of the advertisers relative to the TV channels falls, so that the advertising price increases for any given advertising level. We summarize our results concerning profits:

Proposition 2 *The non-cooperative equilibrium profit levels for the TV channels as well as for the advertisers are higher (i) the more differentiated the TV channels' programs, and (ii) the lower the viewers' disutility of advertising. The larger the number of advertisers, the higher the profit level of the TV channels and the lower the profit level of the advertisers.*

Finally, let us consider collusion between the TV channels. When $s = 0$, the TV channels' products are by definition independent, and collusion has no effect at all. At the other extreme, we know that the TV channels compete away (almost) all advertising and have close to zero profits when s approaches 1. This is a prisoners' dilemma situation, where the firms would have been jointly better off with more advertising on both channels. This suggests that collusion between the TV channels leads to more advertising than in the non-cooperative equilibrium for all $s \in (0,1)$, and more so the less differentiated the TV programs. Formally, we can derive the first-order conditions for a collusive outcome from the TV channels' joint profit maximization problem. We then find that the equilibrium advertising level for channel i equals:

$$A_i^C = \frac{1}{2\gamma}\frac{n}{n+1}, \ i = 1,2. \tag{11}$$

where the superscript C denotes collusion. Note that differentiation as such does not play any role if the TV channels collude. The reason for this is that a reduction in differentiation has no competitive effect in a collusive outcome, and therefore does not trigger any change in the chosen level of advertising.

By substituting A_i^C into the expressions for profit in (4) and (5), we find profits for the TV channels and the advertisers, respectively:

$$\Pi_i^C = \frac{1}{8\gamma}\frac{n}{n+1}, \text{ and } \pi_k^C = \frac{1}{4\gamma}\frac{1}{(n+1)^2}, \; i = 1, 2, \; k = 1, ..., n.$$

The following can now be established:

Proposition 3 *For any $s \in (0,1)$, advertising levels and profits are higher when the TV channels collude than when they act non-cooperatively, and are independent of the degree of product differentiation between the TV channels' programs. Advertising levels and profits respond to changes in viewer disutility of advertising and the number of advertisers qualitatively in the same way as when TV channels act non-cooperatively.*

Proposition 3 suggests that any anti-competitive measure between TV channels increases the amount of advertising. An anti-competitive merger, for instance, will trigger more advertising. Below, we show that this has some interesting welfare implications.

4 Social optimum

We express welfare as

$$W = CS + \Pi_1 + \Pi_2 + \sum_{k=1}^{n} \pi_k. \tag{12}$$

With a total of $A_1 + A_2$ advertising slots on the two TV channels, the advertisers have an aggregate gain from advertising on TV equal to $A_1V_1 + A_1V_2$. The money-equivalent consumer disutility from this advertising equals $\gamma(A_1V_1 + A_1V_2)$. In order to cultivate the mechanisms that could make the media market underprovide advertising, we assume that no additional consumer surplus is generated by the sales of products triggered by TV advertising (we could clearly have too little advertising if this extra surplus were assumed to be high).[13] With this set-up, we thus 'minimize' the social gains from advertising. Accordingly, we can express welfare as

$$W = U + (1-\gamma)(A_1V_1 + A_2V_2).$$

From the welfare function, we immediately see that advertising on TV is socially beneficial if and only if $\gamma < 1$. In contrast, there will be advertising in market equilibrium even when $\gamma \geq 1$. Formally, by solving $\frac{dW}{dA_i} = 0$, $i = 1, 2$, subject to viewer behavior in (2), we find that the socially optimal advertising level equals, for $i = 1, 2$:

[13] Suppose, for instance, that all consumers have the same willingness to pay for each unit of the advertised goods. The producers will then charge the consumers a price equal to their reservation price. See also Anderson and Coate (2005).

$$A_i^* = \begin{cases} \frac{1-\gamma}{\gamma(2-\gamma)}, & \text{if } 0 < \gamma < 1 \\ 0, & \text{if } \gamma \geq 1 \end{cases} \quad (13)$$

Note that the socially optimal amount of advertising is independent of how close substitutes the TV channels' programs are (*i.e.*, it is independent of s). This is natural, since commercials are equally disturbing for the consumers regardless of the extent of horizontal differentiation between the TV channels. The optimal level of advertising is thus only a function of γ, the viewers' disutility parameter. Differentiation of (13) further shows the intuitively obvious result that A_i^* is decreasing in consumers' disutility of advertising for all $\gamma \in (0, 1)$.

Inserting for A_i^*, we find that welfare in social optimum equals

$$W^* = \begin{cases} \frac{1}{2\gamma(2-\gamma)}, & \text{if } 0 < \gamma < 1 \\ \frac{1}{2}, & \text{if } \gamma \geq 1. \end{cases} \quad (14)$$

From (14) we see that $\frac{dW^*}{d\gamma} < 0$ for $\gamma \in (0, 1)$. The reason for this relationship is two-fold. First, consumer surplus is decreasing in γ. This is a direct effect. Second, there is an indirect effect through the disutility parameter's effect on the advertising level. We know that higher disutility leads to a lower amount of advertising in social optimum ($\frac{dA_i^*}{d\gamma} < 0$ for $\gamma \in (0, 1)$). This results in a reduction in society's use of value-enhancing TV commercials.

To sum up, we have:

Proposition 4 *In social optimum, advertising levels and welfare are decreasing in viewers' disutility from watching advertising, and there is no advertising in optimum if this disutility is sufficiently high ($\gamma \geq 1$). Welfare is independent of the degree of product differentiation and the number of advertisers.*

5 A comparison

As noted above, the equilibrium outcome depends on whether TV channels compete or collude. Let us therefore first compare the social optimum with the non-cooperative equilibrium, and then with the collusive equilibrium.

In market equilibrium there will be advertising for all values of γ, but it is socially optimal not to have any advertising if $\gamma \geq 1$. The excess level of advertising on each channel in market equilibrium in this case is trivially given by equation (8). The interesting case to consider is therefore $\gamma < 1$. Using equations (8) and (13), we find that the difference between advertising levels in social optimum and in equilibrium can be written as

$$A^* - A^M = \frac{n(1+\gamma) - 3(1-\gamma)}{\gamma(2-\gamma)(n+1)(4-3s)}(s - \hat{s}), \quad (15)$$

where

$$\hat{s} = \frac{2\left[\gamma(n+2) - 2\right]}{n\left(1+\gamma\right) - 3\left(1-\gamma\right)}. \tag{16}$$

Equation (15) shows that there is too much advertising in market equilibrium if and only if $s < \hat{s}$.[14] The driving force behind this result is the fact that TV stations have high market power over their viewers when the channels' program contents are poor substitutes (s small). The TV channels exploit this market power by selling a larger amount of advertising slots to the advertisers, even though this reduces viewers' utility from watching TV. However, competition for viewers forces the TV channels to reduce their level of advertising, and more so the closer substitutes their programs. Indeed, we have shown that, independent of viewers' disutility of advertising, the equilibrium advertising level equals zero in the limit as s approaches one. This is obviously below social optimum if $\gamma < 1$. More generally, competition between the TV channels is so tough if $s > \hat{s}$ that there is underprovision of advertising in equilibrium. Naturally, $\frac{d\hat{s}}{d\gamma} > 0$: the higher the viewer's disutility from advertising, the smaller is the range of s for which there is underprovision of advertising.

Using equations (8) and (12), we can express welfare in the non-cooperative equilibrium as

$$W^M = \frac{\left[(2-s)\,n + (4-3s)\right]\left[(2-s)\,\gamma n + (4-3s)\,\gamma + 4n\,(1-s)\right]}{2\gamma\,(4-3s)^2\,(n+1)^2}, \tag{17}$$

By differentiating (17) with respect to s and n, we have:

$$\begin{aligned}
\frac{dW^M}{ds} &= -\frac{2n\left[n\left(1+\gamma\right) - 3\left(1-\gamma\right)\right]}{\gamma\,(4-3s)^3\,(n+1)^2}\left(s-\hat{s}\right), \text{ and} \\
\frac{dW^M}{dn} &= \frac{2\left[n\left(1+\gamma\right) - 3\left(1-\gamma\right)\right](1-s)}{\gamma\,(4-3s)^2\,(n+1)^3}\left(s-\hat{s}\right).
\end{aligned}$$

There is too much advertising in market equilibrium if $s < \hat{s}$. In this case, an increase in s or a reduction in n (which corresponds to a downward-shift in demand for advertising) results in higher welfare, since less product differentiation or a smaller number of advertisers would result in less advertising. Likewise, more product differentiation and a larger number of advertisers would be welfare improving if $s > \hat{s}$, since in that case there will be too little advertising from a social point of view. Indeed, if the consumers' disutility of advertising is sufficiently low, even a monopoly TV station ($s = 0$) will have too little advertising from a social point of view if n is small.

The relationship between advertising in the non-cooperative equilibrium and in social optimum is illustrated in the left-hand side panel of Figure 1. The curves labelled $A^M_{n=1}$ and A^M_n correspond to equilibrium in the case of $n = 1$ and $n \to \infty$ advertisers,

[14] It is straightforward to show that $\hat{s} > 1$ (such that $s - \hat{s} < 0$) if $n\left(1+\gamma\right) - 3\left(1-\gamma\right) < 0$. Therefore, $sign(\bar{A}^* - \bar{A}^M) = sign(s - \hat{s})$.

respectively. For all $s < 1$, the latter curve has the higher values. This is because the equilibrium level of advertising is increasing in n. The social optimum, on the other hand, is independent of n. The right-hand side panel of Figure 1 shows the corresponding relationship between channel differentiation and welfare. Note in particular the inefficiency of the market economy for high values of s.

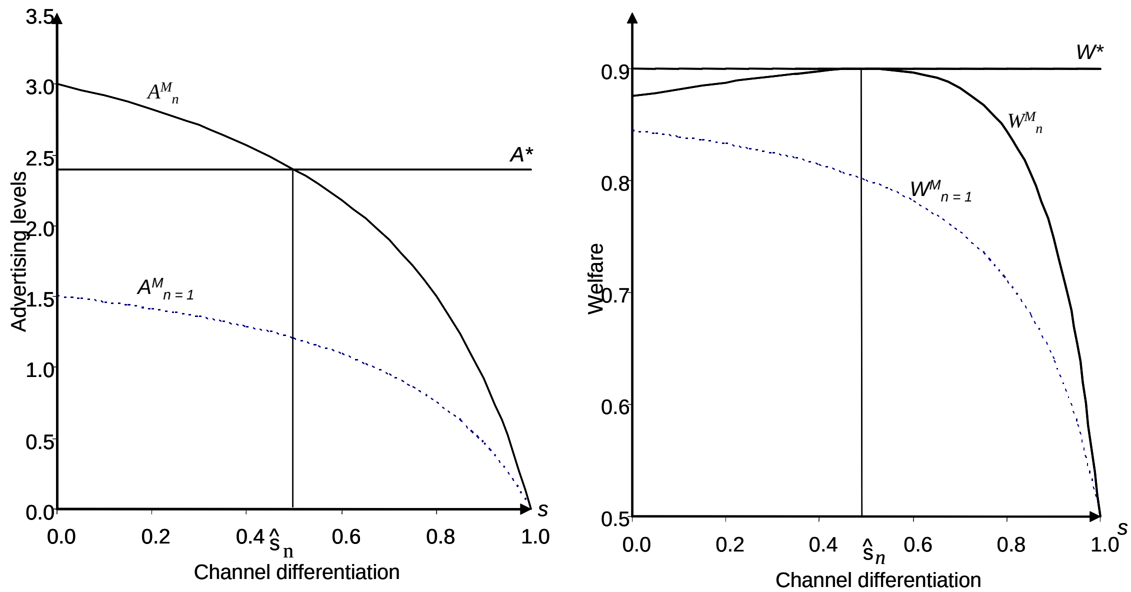

Figure 1: *Comparison between social optimum and market equilibrium.*

We can summarize our results as follows:

Proposition 5 *In an equilibrium where the TV channels act non-cooperatively, there is too little advertising if the TV channels' programs are close substitutes, in particular if $s > \hat{s}$, and too much advertising if $s < \hat{s}$.*

Finally, let us compare the collusive outcome with the social optimum. When the TV channels collude, they are able to counter the effect of product differentiation. Therefore, advertising levels will be independent of s. This is true also for social optimum, and by comparing (11) and (13) we find:

Proposition 6 *In an equilibrium in which the TV channels collude, there is too little advertising if $\gamma < \frac{2}{n+2}$ and too much advertising if $\gamma > \frac{2}{n+2}$.*

We know that a shift from competition to collusion leads to more advertising. However, Proposition 6 shows that there can be underprovision of advertising even with collusion. The reason for this is that, for any finite number of n, the advertisers will have some market power over the TV channels ('monopsony power'). All else equal, this means that demand for advertising is too small from a social point of view. Only in the limit as $n \to \infty$ will it be true that collusion between the TV channels necessarily generates too much advertising.

6 Public policy: Mixed duopoly

The analysis above suggests that the level of advertising in market equilibrium may be too high from a social point of view, particularly if the TV channels are poor substitutes. In this case a public regulation that puts an upper limit on the amount of advertising may be a welfare enhancing policy. Such a policy has been implemented in many countries.[15] Obviously, binding restrictions on the amount of advertising are detrimental to welfare if the market provides too few commercials. However, in such a case, other measures might help. One possibility could be to welcome mergers, as indicated above.

Regulation of advertising levels on private TV channels has proven to be increasingly difficult over time. One reason for this is that the regulators are exposed to lobbying pressure. Another reason, which is probably more important (and increases the power of lobbyists), is that technological progress and increased globalization make it increasingly more difficult to enforce an efficient regulation policy towards private TV channels.[16] It is natural to ask, therefore, how governments can affect the equilibrium outcome through ownership of a TV station.

The presence of one public and one or more major private TV channels (mixed oligopoly) is common in many European countries.[17] While public TV channels historically have not been financed by advertising, this has gradually changed over time (*e.g.*, by allowing firms to sponsor programs). The main reason for the change is the fact that for instance expensive sport events have made it politically more difficult to finance public TV channels through licenses. However, we will not consider this financial aspect. Instead, we consider a situation where the government owns channel 1 (*TV1*), which maximizes welfare (W) with respect to its own level of advertising. The advertising level on the other channel (*TV2*) is assumed to be unregulated.

The TV channels simultaneously set advertising levels at stage 1 and the producers decide how many advertising slots to buy at stage 2. Now the advertising level at channel 1 is set according to $A_1 = \arg\max W$, while $A_2 = \arg\max \Pi_2$. We consider only the non-cooperative outcome.

Independently of who owns the TV channels, the outcome of stage 2 is given by

[15] See Motta and Polo (1997) and Anderson (2005).

[16] One example of this comes from Norway, where there are restrictions on allowed advertising levels. Even though these restrictions have become less severe over time, the private station TV3, owned by Modern Times Group AB, has chosen to broadcast from the UK to the Norwegian market in order to avoid the Norwegian restrictions on advertising levels. Thus, it is not merely an empty threat when TV stations argue that they will serve the market from abroad if there is a strict regulation of advertising levels.

[17] There are several studies of mixed duopoly, see for example De Fraja and Delbono (1989) and Cremer *et al.* (1991). Nilssen and Sørgard (2002) present, as far as we know, the only mixed-oligopoly study relating to the media industry. However, their study is a Hotelling model, not capturing consumers' disutility from advertising. In a related study, Nilssen (2000) discusses mixed oligopoly in a payments market where, like in the present media context, there are negative externalities among firms in addition to the traditional oligopoly externality.

equation (7). Provided that both TV channels have positive advertising levels (see below), we find that stage 1 yields the following advertising levels:

$$A_1^P = (1-s)\frac{2\left[s\gamma n + 2(1-\gamma)(2(n+1)-s)\right]}{\gamma(n+1)\left[8(1-s)+s^2\right](2-\gamma)}, \text{ and} \tag{18}$$

$$A_2^P = (1-s)\frac{2\left[s(1-\gamma-n)+2n(2-\gamma)\right]}{\gamma(n+1)\left[8(1-s)+s^2\right](2-\gamma)}. \tag{19}$$

We see that the potential problem of no advertising at all as s approaches 1 remains unsolved even with a government-owned TV channel. The reason is that, since the TV channels are almost perfect substitutes in this case, imposing advertising on the public channel would make all viewers watch the private channel.

In Section 5 above, we found that there is too little advertising in equilibrium if $s > \hat{s}$. Consistent with this, we have

$$A_1^P - A_2^P = (1-s)\frac{2\left[n(1+\gamma)-3(1-\gamma)\right]}{\gamma(n+1)\left[8(1-s)+s^2\right](2-\gamma)}(s-\hat{s}).$$

This means that the publicly owned TV channel will advertise more than the private, profit-maximizing TV channel if $s > \hat{s}$. This is quite natural, since, by so doing, it partly corrects for the underprovision of advertising that would have been the case if both channels had been private, profit-maximizing entities.

Figure 2 illustrates the difference between the advertising levels when $\gamma = \frac{1}{3}$ for the limit case $n \to \infty$. In the neighborhood of $s = \frac{1}{2}$, we see that the public channel advertises increasingly more than the private channel the closer substitutes the TV stations are. However, since the Bertrand-paradox style result that there will be no advertising in the limit as the channels are about to become perfect substitutes is still present, the curve is downward-sloping when s approaches 1.

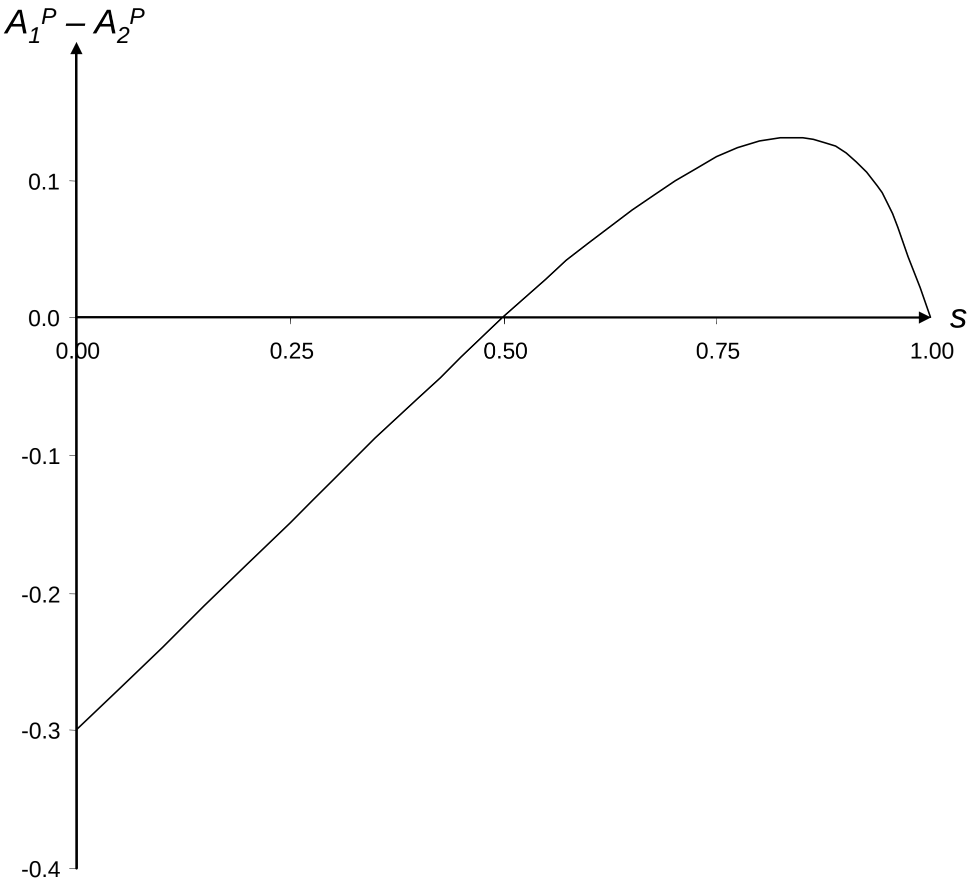

Figure 2: *The difference in advertising between the public and the private channel (for* $\gamma = \frac{1}{3}$ and $n \to \infty$*).*

Suppose that $\gamma > 1$, in which case there will be no advertising in social optimum. Does this mean that a public TV channel in a mixed duopoly should carry no advertising? – No, not necessarily. From equation (18) we find that $A_1 > 0$ if $\gamma < \tilde{\gamma} \equiv 1 + \frac{sn}{4(1+n)-(2+n)s}$, where $\tilde{\gamma}$ is strictly increasing in s and n. Since $\tilde{\gamma}$ is generally greater than 1, we see that the government may find it optimal to allow advertising on its own channel even when advertising is wasteful as such. This is because public-channel advertising has an indirect positive effect on the surplus generated by the private TV channel. To see this, consider the limit case when $n \to \infty$. If $\gamma = 1$, then advertising has neither a positive nor a negative social value *per se*. The direct effect of a marginal increase in A_1 is to generate some profit for *TV1* that is exactly matched by a loss in consumer surplus. However, the indirect effect of the increase in A_1 is to make *TV2* relatively more attractive for any given advertising level A_2. Thereby, *TV2* will observe a positive shift in its demand for advertising and thus have a non-marginal increase in profits. The net effect of the higher A_1 is thus to improve welfare due to the higher profit level for *TV2*. From this, it follows that it must be optimal to set A_1 strictly positive when $\gamma = 1$. By continuity, the same must be true also if γ is somewhat larger than 1.[18]

If $\gamma > \tilde{\gamma}$, then the publicly owned *TV1* sets $A_1^P = 0$. Inserting for this, we can then use equations (4) and (7) to find that profit maximizing behavior by *TV2* implies

$$A_2^P = \frac{1}{\gamma}\left(\frac{n}{n+1}\right)\frac{1-s}{2-s}. \tag{20}$$

In this case there is obviously too much advertising from a social point of view. From equation (20), we further see that the advertising level is decreasing in s and increasing in n, as is the case in the market equilibrium where both TV stations are profit maximizing firms.

We can summarize our results as follows:

Proposition 7 *In a mixed duopoly, the public TV channel has the higher advertising level if and only if $s > \hat{s}$. Moreover, the public TV channel may carry advertising even when advertising is socially wasteful, which happens for $1 < \gamma < \tilde{\gamma}$.*

The second statement in Proposition 7 is illustrated graphically in Figure 3 for $\gamma = 1.1$ and $n \to \infty$.

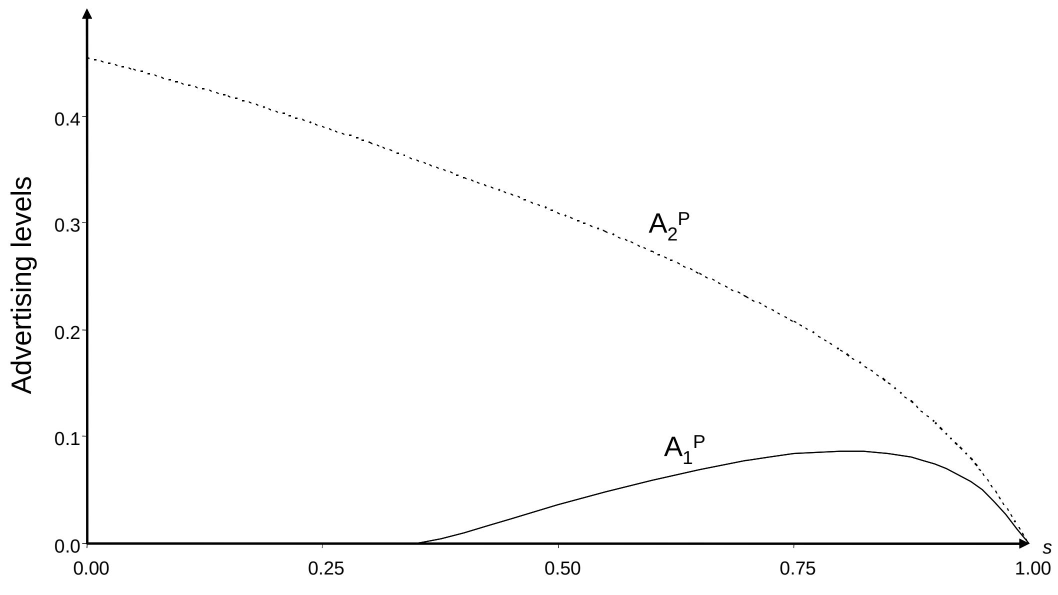

Figure 3: *Advertising levels when advertising is intrinsically wasteful (for $\gamma = 1.1$ and $n \to \infty$).*

[18]Note that there is no reason to set $A_1 > 0$ if $\gamma \geq 1$ and $s = 0$. The reason for this is that the two TV channels' programs now are completely independent, so that the advertising level on *TV1* does not have any indirect effect on the profit level of *TV2*.

7 The oligopoly case

Over the last decades, the number of TV stations has increased in most countries. In order to analyze the welfare effects of this, we shall modify the utility function to allow for an arbitrary number of TV channels. With m channels, the utility function in equation (1) can be reformulated as

$$U = \sum_{t=1}^{m} V_t - \left[\frac{m}{2} (1-s) \sum_{i=1}^{m} (V_i)^2 + \frac{s}{2} \left(\sum_{i=1}^{m} V_i \right)^2 \right].$$

Maximization of consumer surplus, $CS = U - \gamma \sum_{i=1}^{m} A_i V_i$, yields

$$V_i = \frac{1}{m} - \frac{1}{m^2} \gamma \frac{m A_i - s \sum_{t=1}^{m} A_t}{1-s}. \tag{21}$$

We maintain the same timing structure as above, and solve $\frac{d\pi_k}{dA_{ik}} = 0$ $(i = 1,..,m; k = 1,...n)$ simultaneously for the n advertisers at stage 2. Thereby we find that demand for advertising at TV channel i equals

$$A_i = \frac{1}{\gamma} \frac{n}{n+1} \left(1 - \left[m - (m-1) s \right] R_i - s \sum_{t \neq i} R_t \right), \ i = 1, ..., m,$$

so that the inverse demand function can be written as

$$R_i = \frac{1}{m} - \frac{\gamma}{m^2} \left(\frac{n+1}{n} \right) \frac{(m-s) A_i - s \sum_{t \neq i} A_t}{1-s}, \ i = 1, ..., m. \tag{22}$$

At stage 1 the m TV stations non-cooperatively set advertising levels. Solving $\frac{d\Pi_i}{dA_i} = 0$, $i = 1,..,m$, subject to (22), we find

$$A_i^M = \frac{1}{\gamma} \left(\frac{n}{n+1} \right) \frac{m(1-s)}{m(1-s) + m - s}, \ i = 1, ..., m. \tag{23}$$

Insertion of (23) into (21) further implies that

$$V_i^M = \frac{(n+1)(m-s) + m(1-s)}{m(n+1)\left[(m-s) + m(1-s) \right]}, \ i = 1, ..., m. \tag{24}$$

In one-sided markets, a larger number of competitors typically reduces output for each single firm and increases total output. It can be shown that the same holds also in our two-sided market structure: each TV channel has less advertising and a smaller audience the larger the number of competitors ($\frac{dA_i^M}{dm} < 0$, and $\frac{dV_i^M}{dm} < 0$), but total output is increasing in m ($\frac{d(mA_i^M)}{dm} > 0$, and $\frac{d(mV_i^M)}{dm} > 0$).

Using equations (22) and (23), we find that the slotting price equals

$$R_i^M = \frac{m-s}{m\left[m\left(1-s\right)+m-s\right]},\ i=1,...,m. \tag{25}$$

Above, we showed that the slotting price is lower the closer substitutes the consumers perceive the TV channels to be. This is because reduced differentiation increases the competitive pressure. If consumers dislike ads, then the TV channels will subsequently have less advertising and a higher equilibrium price on ads. Not surprisingly, we therefore find that $\frac{dA_i^M}{ds} < 0$ and $\frac{dR_i^M}{ds} > 0$ also when we have an arbitrary number of TV channels. The same kind of reasoning might lead one to expect that the slotting price is increasing also in the number of TV channels. This is not true. From equation (25) we find, on the contrary, that[19]

$$\frac{dR_i^M}{dm} = -\frac{m\left(m-2s\right)\left(2-s\right)+s^2}{m^2\left[m\left(1-s\right)+m-s\right]^2} < 0. \tag{26}$$

The intuition for why $\frac{dR_i^M}{dm} < 0$ is that the market power of each TV channel falls when the number of channels increases. This forces the TV channels to reduce the slotting prices, an effect which again is well known from one-sided markets. However, the contact price per viewer ($r_i^M = \frac{R_i^M}{V_i^M}$) is unambiguously increasing in the competitive pressure [if $s \in (0,1)$]. This holds whether the higher pressure is caused by a larger number of competitors or by less product differentiation:

$$\begin{aligned} \frac{dr_i^M}{dm} &= \frac{\left(n+1\right)s\left(1-s\right)}{\left[\left(n+1\right)\left(m-s\right)+m\left(1-s\right)\right]^2} > 0, \text{ and} \\ \frac{dr_i^M}{ds} &= \frac{m\left(m-1\right)\left(n+1\right)}{\left[\left(n+1\right)\left(m-s\right)+m\left(1-s\right)\right]^2} > 0,\ i=1,...,m. \end{aligned}$$

It thus becomes more expensive for the advertisers to reach each viewer the larger the number of channels. We therefore get the somewhat surprising result that the profit level of the advertisers is decreasing in the number of TV channels:

$$\frac{d\pi_k^M}{dm} = -\frac{2m^2\left(1-s\right)^2 s}{\gamma\left(n+1\right)^2\left[m\left(1-s\right)+m-s\right]^3} < 0,\ k=1,...,n.$$

Quite obviously, the TV channels are worse off the larger the number of competitors ($\frac{d\Pi_i^M}{dm} < 0$), since both the banner price and the advertising level are decreasing in m. However, the lower advertising level on each channel is an advantage for consumers.

[19] It is evident from equation (26) that $\frac{dR_i}{dm} < 0$ for $m \geq 2$. To see that the advertising price decreases also when we go from one to two TV channels, we note that $R(m=2) - R(m=1) = \frac{2-s}{2(4-3s)} - \frac{1}{2} = -\frac{1-s}{4-3s} < 0$ for $s < 1$.

Additionally, consumers gain because an increase in m means that the diversity of TV channels increases. We thus unambiguously have $\frac{dCS}{dm} > 0$.

With m channels, the welfare measure in equation (12) must be modified to

$$W = CS + \sum_{i=1}^{m} \Pi_i + \sum_{k=1}^{n} \pi_k. \tag{27}$$

Inserting for equilibrium values of advertising prices and levels, we find

$$W^M = \frac{[m(1-s) + (n+1)(m-s)][\gamma(n+1)(m-s) + m(1-s)(\gamma+2n)]}{2\gamma [m(1-s) + m - s]^2 (n+1)^2}$$

Since an increase in m means that profits fall and consumer surplus increases, it is clear that the welfare effects of a larger number of TV channels are ambiguous:

$$\frac{dW^M}{dm} = \frac{ns(1-s)[(2m - s(1+n+m))(\gamma - 1) + nm(\gamma - s)]}{\gamma [2m - s(1+m)]^3 (n+1)^2} \gtreqless 0. \tag{28}$$

More interestingly, by differentiating equation (28) we find

$$\frac{d^2 W^M}{dm d\gamma} = \frac{n(1-s)s[ns(m-1) + 2m - s(1+m)]}{\gamma^2 [2m - s(1+m)]^3 (n+1)^2} > 0. \tag{29}$$

Equation (29) has the non-trivial implication that the welfare effect of a larger number of advertising-financed TV channels is more likely to be positive the higher the consumers' disutility from advertising. While this result may not be obvious at the outset, the intuition is quite clear: Competition forces each of the existing TV channels to reduce its level of advertising, and the social gain from this is higher the more consumers dislike advertising. Indeed, if $\gamma > 1$ we know that advertising is socially wasteful, and that any reduction in advertising must have positive welfare effects.

Summing up, we have

Proposition 8 *Suppose that the number of TV channels increases. Then*

a) the price per advertising slot falls, while the contact price per viewer increases.

b) the profit levels of the TV channels and the advertisers fall, while consumer surplus increases.

c) aggregate welfare is more likely to increase the greater the viewers' disutility of advertising.

8 Concluding remarks

In contrast to most of the existing literature, we have modeled the media firm as an intermediate player that transmits advertising to consumers. Our starting point is that advertising-financed TV is a mixed blessing. Advertising is good for the sales of products because it generates a surplus, and bad for viewers because they typically dislike being interrupted by commercials on TV. However, we have shown that underprovision of advertising may happen, and is more likely the less differentiated are the TV channels' programs. In such situations, restrictions on the amount of advertising can be detrimental to welfare. In fact, it may actually be welfare enhancing to allow an anti-competitive merger between TV channels.

We also point out that the nature of competition as such may be crucial for whether there is over- or underprovision of advertising on TV. If the TV channels collude on advertising, they will succeed in having a relatively large amount of advertising on TV. However, as shown above, there may be underprovision of advertising even in this case. This happens if the advertisers have high market power over the media firms and the TV viewers have a relatively low disutility from being interrupted by ads.

From a public-policy point of view, it is important to note that, since advertising is easily observable, there might be scope for collusive behavior between TV channels. If TV channels are observed to advertise a lot even in a situation where their programs appear to be rather close substitutes, this is an indication that there is collusion on advertising. An alternative to imposing restrictions on advertising might then be for competition authorities to actively scrutinize the TV channels.

On the question of whether a policy of removing public barriers to entry for advertising-financed TV channels would be negative from a welfare point of view, we find, somewhat paradoxically, that there may be good reasons to encourage such entry if consumers have a strong distaste for advertising.

Our analysis is based on the notion that the degree of product differentiation, as represented by the parameter s, is observed and known by everybody, including the social planner. One can certainly envision a richer model where there is uncertainty about this feature of viewers' preferences. This could be an interesting extension, not least from a policy point of view. However, we believe that there will be no qualitative changes in the mechanisms we have highlighted even if such uncertainty is introduced.

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