Every Viewer has a Price - On the Differentiation of TV Channels*

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Abstract

This study has three main objectives. First, we develop a realistic framework for studying the incentives to differentiate broadcasting in free-to-air TV markets. Consumers are allowed to vary the amount of time spent in front of the television set depending on preferences over program types (e.g., entertainment versus news), differences in the alternative cost of time and an Hotelling type dimension reflecting i.e., political positioning. Second, since empirical evidence suggest that different consumer segments are priced differently in the market for advertising, we analyze the implications of targeted advertising on the equilibrium level of differentiation. Third, we compare the equilibrium outcome with the socially optimal configuration. When consumers have no preferences over program types, standard Hotelling type results apply. Market forces minimize differentiation while the optimal degree is at an intermediate level. As preferences over program types get stronger the difference between optimal and market outcomes is initially reduced. However, when a large enough number of consumers start flipping between channels in order to avoid the least preferred program type, minimal differentiation suddenly becomes optimal while market forces leads to excessive differentiation. Hence, policies aimed at increasing diversity is beneficial only when viewers care little about program content.

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1 Introduction

Media markets in general and television markets in particular have attracted the attention of economists for more than fifty years. One reason is of course that they are significant in terms of size. According to the Television Bureau of Advertising (2010), U.S. advertisers spent more than 46 billion USD on television ads alone in 2008. Equally important is the fact that we spend a significant amount of our leisure time watching TV. For example, US consumers watch some eight hours a day on average. See Anderson and Gabszewicz (2006). It is also the case that broadcasting media share a number of important features that are likely to lead to economic inefficiencies. At least three important concerns have been raised in the literature.

First, it is often argued that the two-sidedness of media markets may introduce various distortions.¹ The two-sidedness comes from the fact that Commercial television and radio channels operate simultaneously in the market for viewers and listeners and in the market for advertising. One possible market outcome is a natural monopoly equilibrium where one firm corners the market and earns positive profits. See Häckner and Nyberg (2008). A second concern is the extent to which the market mechanism leads to excessive advertising, i.e., too low advertising rates. Here, the literature provides no clear-cut results. See e.g., Andersson and Coate (2005).²

Our study is primarily related to the third major policy concern, namely how market forces determine the degree of product differentiation across channels. Evidently, standard economic efficiency aspects of media are often outweighed by concerns that decreased political or cultural differentiation among the products offered by media firms may have adverse effects on the democratic process. Our point of departure is the fact that the advertising market has undergone a dramatic change during the last ten to fifteen years in the sense that advertisers to a large extent has abandoned mass

¹See e.g., Rochet and Tirole (2003), Armstrong (2005), Caillaud and Jullien (2001), Caillaud and Jullien (2003).

²Other contributions can be found in Choi (2006), Brown and Alexander (2005), Dukes (2004), Cunningham and Alexander (2004), Kind, Nilssen and Sorgard (2003) and Masson, Mudambi and Reynolds (1990).

advertising in favor of so called targeted advertising. See e.g., Bianco (2004), The Economist (2005), Anderson and Gabszewicz (2006) and Bagwell (2007). As network television viewership has declined, the cost per viewer has increased significantly. At the same time, internet advertising, which to a greater extent allows targeting, has become more and more important in the strive to reach new consumers. Hence, both cost effectiveness concerns and the access to a new technology have made advertisers more inclined to make sure that their advertisements reach their target groups and no one else. Broadly speaking, the purpose of our study is to discuss how the evolution of targeted advertising may have affected the incentives to differentiate products in free-to-air broadcasting markets.

There is a large number of previous studies that investigate the mechanisms determining the degree of product differentiation in commercial broadcasting industries. Here, we will only mention a few of them. A standard reference is Steiner (1952) who analyzes a situation where radio listeners can only listen to one channel each. Competition for listeners will then lead to excessive duplication in the sense that choosing popular programs and splitting the audience among channels can be a more profitable strategy than broadcasting less popular programs with unique audiences. Spence and Owen (1977) study biases in program selection under monopolistic competition and pay-TV. Using the sum of producers' and consumers' surplus as the welfare standard, it is shown that a bias in program selection will always be present due to the fact that prices do not perfectly capture the intensity of consumer preferences. Specifically, there will be under-provision of programs facing a low own-price elasticity (i.e., minority taste programs) and programs that are expensive to produce. Generally, pay-TV channels bias their broadcasts to a lesser extent than advertising supported channels since pay-TV prices mirror consumer preferences in a better way compared to advertising rates. Peitz and Valetti (2004) discuss how product differentiation is affected by broadcasting firms' ability to charge consumers for their broadcasts. They find that free-to-air television tends to provide more similar program content since consumers' willingness to pay for program content cannot be captured by firms. They also find that any degree of differentiation is possible depending on the magnitude of

the nuisance cost. Finally, Dukes and Gal-Or (2004) analyze how advertising rates and incentives to advertise are determined in negotiations between media (radio) stations and producers. Both products and stations are assumed to be differentiated. Increased product differentiation in the media market results in more advertising, but lower profits for producers as well as stations. On the other hand, producers and stations both gain from product differentiation in the product market.

A key feature in our study is that we want to take into account the fact that all consumers do not watch television to the same extent due to preferences and/or differences in the alternative costs of time. Elderly people, for example, are known to consume much more television compared to young men. This, in turn, has important implications for the advertising rates charged for reaching different subsets of the population. Essentially, the product sold by TV channels is not so much "programs" as viewer exposure and advertising rates are typically contingent on specific groups. For example, channels may quote a specific price for reaching say 1000 males between 15 and 25 years of age. It is then up to the network to schedule advertisements so that this goal is achieved. Groups that rarely watch television are relatively more expensive to reach compared to other groups. There are at least two reasons for this. First, the amount of advertising that can be broadcasted on an hourly basis is often regulated by the government, and if not, nuisance costs puts a natural limit to advertising. Hence, the demand for advertising slots in connection to e.g., major sports events, that typically attract the attention of young men, will be large relative to supply. Secondly, people who watch a lot of television will tend to watch several channels and be exposed to several commercial breaks. Competition for selling viewer exposure to such people will therefore be more intense. On the other hand, a channel that manages to capture the interest of a group that seldom watches television will have more of a monopoly position towards advertisers. If different viewer groups generate different revenues it seems important to try to see through the implication of this for the functioning of broadcasting markets and specifically for possible tendencies to excessive duplication. One possible hypothesis is that targeted advertising may mitigate the problems addressed by Spence and Owen (1977) in the sense that catching

niche audiences may result in higher revenues than broadcasting for the masses.

In order to demonstrate that advertising rates and viewing patterns are indeed related we have done some empirical estimations. The data set covers prime time list prices for all major commercial TV channels broadcasting for the Swedish audience in 2007. In all, there are 77 observations. All data plus references are available in the Appendix. The channels in question are TV3, TV4, Kanal 5 and Discovery channel. Their combined market share, in terms of total viewing time, was 48.2 percent. Remaining market shares are split between the two major public service channels (32.2 percent) and a number of smaller channels (18 percent) consisting of a mixture of commercial free-to-air channels and pay-TV channels without commercial breaks. Hence, the data set provides more or less a complete picture of Swedish prime time list prices for commercial advertising in 2007. Discounts were sometimes offered but such information is not publicly available. The prices correspond to what is referred to as *Cost Per Thousand* or *CPT*, that is they are defined in terms of the cost of reaching one thousand additional individuals belonging to a target audience. Quoted prices are contingent on gender (male, female or mixed target audiences) and age cohorts. We have data on the average time spent watching TV for all target audiences and, as argued above, we would expect groups that rarely watch to be relatively more expensive to reach. As can be seen from *Table 1*, raw correlations between time spent watching (*Time*) and prices (*CPT*) are quite high for all channels apart from Kanal 5, which is explicitly niched towards a young audience (ages 15-44).³ This is illustrated graphically in *Figure 1* which simply plots *Time* and *CPT* for all channels. Hence, we may conclude that our point of departure, namely that it is expensive to reach groups that rarely watch TV, seems to be closely in line with actual market data.

The model of the TV market that we construct differs from earlier ones in four important respects. First, viewers have the the choice between watching zero, one

³Data on TV habits was collected by MMS (Mediamätning i Skandinavien), a Swedish equivalent to the Nielsen Group owned primarily by TV channels (www.mms.se). Price data was collected directly from the channels.

or two channels. Second, we take into account that market forces will drive a wedge between advertising rates for *unique* viewer exposures and for shared or *common* viewer exposures. In the former case the TV channel has a monopoly power in relation to advertisers while in the latter case the same viewer watches both channels and are hence reached by commercial messages from two sources. Third, we take explicitly into account that viewing patterns are determined by time costs that differ across individuals. Fourth, viewers are assumed to be heterogeneous in terms of preferences over program types, e.g., news versus entertainment.

We reach the following main conclusions. When consumers have no preferences over program types, standard Hotelling type results apply. Market forces minimize differentiation (e.g., in terms of political positioning) while the optimal degree is at an intermediate level. As preferences over program types get stronger the difference between optimal and market outcomes are initially reduced. However, when a large enough number of consumers start flipping between channels in order to avoid the least preferred program type, minimal differentiation becomes optimal while market forces lead to excessive differentiation. Hence, policies aimed at increasing diversity is beneficial only when viewers care little about program content.

The paper is organized as follows: In section 2 the basic model is presented and the equilibria are characterized. In section 3 we discuss welfare implications and the paper concludes with some final remarks in section 4.

2 The model

The model is based on Hotelling (1929). The number of channels is restricted to two ($C1$ and $C2$) and each channel is allowed to produce only one variety. Consumers have preferences in two dimensions. First, they are assumed to be uniformly distributed by taste along a line of unit length and the channels are broadcasting varieties a_1 and $1 - a_2$ respectively. This dimension could for example reflect political positioning or the extent to which broadcasted programs are intellectually demanding. Let us denote this dimension the *channel profile*. Second, consumers have preferences over

program types. Let there be two types, say news and entertainment, and let half of the consumers prefer news to entertainment and vice versa. It is assumed that each channel broadcasts one program of each type. Hence, each channel broadcasts two programs every evening and they do it during the same time interval. However, while *C1* broadcasts entertainment (news), *C2* broadcasts news (entertainment). Endogenous TV listings will indeed have this feature unless the price premium for unique viewer contacts is very high. In fact, this premium has to be larger than hundred percent for homogenous listings to be optimal (See the Appendix).

Watching TV is modeled as a partly indivisible good. One can think of it in terms of a consumer watching zero, one or two programs. What we want to capture is simply that people with low time costs spend more time watching TV. Therefore, they are also more likely to watch both channels. There is a disutility/transportation cost associated with not being able to watch the ideal channel profile. For each ideal channel profile there is a continuum of viewers with uniformly distributed time costs w associated with watching one program. This cost can reflect income or preferences towards TV in general. The assumptions above have the following implications: Viewers with high time costs will not watch TV at all. Viewers that have moderate time costs will watch one program of the favorite type and they will choose the channel located closest to the ideal channel profile. Viewers with low time costs and with ideal channel profiles close to an actual profile will watch that channel during the entire evening. Viewers with low time costs and ideal profiles in between actual channel profiles may want to watch both channels. Such viewers will of course stick to the favorite program type during the entire evening, i.e., they will flip between channels.

In order to capture these aspects, let utility for a consumer with an ideal channel profile $\theta \in [0, 1]$ and a time cost $w \in [0, W]$ be given by

$$U(a_1, a_2) = \begin{cases} S - t|\theta - a_1| - w & \text{if watching one program in } C1 \\ S - t|1 - a_2 - \theta| - w & \text{if watching one program in } C2 \\ (1 + z)S - 2t|\theta - a_1| - 2w & \text{if watching } C1 \text{ all evening} \\ (1 + z)S - 2t|1 - a_2 - \theta| - 2w & \text{if watching } C2 \text{ all evening} \\ 2S - t|\theta - a_1| - t|1 - a_2 - \theta| - 2w & \text{if flipping} \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

where the utility from watching both channels is simply the sum of the utility levels obtained when watching the two channels separately. The parameter S measures the gross utility from watching a TV program while t captures the disutility from not being able to watch the ideal channel profile, i.e., it is equivalent to the transportation cost in a standard Hotelling type model. We let the positive constant $z < 1$ reflect the fact that viewers that stick to one channel for the entire evening will benefit less from the least preferred program type. The absolute values represent the distances in product space between the ideal channel profile and the profiles offered by $C1$ and $C2$ respectively. Obviously, a viewer watching both channels will obtain a lower marginal utility for the services provided by the channel located furthest away in product space. Some real world consumers have time costs that are so high that they never watch TV. Hence, it is assumed that $W > S$ which, in turn, makes the total number of potential viewers with a certain preference parameter θ , equal to S . Let the term *critical time cost* refer to a threshold determining viewing behavior, i.e., it is a threshold determining whether or not a specific person watches television at all or whether he/she watches one or two programs. For consumers whose ideal profile happens to coincide with the location of say $C1$, demand will be positive for all $w \in [0, S]$ but for viewers with ideal channel profiles further away from a_1 the critical time cost is lower.

Firms choose location only, i.e., they choose channel profiles. The analysis is par-

tial in the sense that we do not model explicitly the market for advertising. Instead, we simply assume that market forces will drive a wedge between advertising rates for *unique* viewer exposures and shared or *common* viewer exposures. Specifically, a viewer exposure is unique if the person in question watches only one channel, while "flippers" generate common viewer exposures. The specification is hence quite general and consistent with most plausible market structures in the advertising market. We can think of a situation where product market firms have access to a constant return technology. Then, the willingness to pay for attracting the interest of an additional buyer is likely to be constant. TV channels may then extract all surplus associated with unique viewer exposure while competition will drive the price of common exposures down. The assumption of a perfectly elastic advertiser demand implies that only consumer surplus matters from an economic efficiency point of view. The amount of commercials broadcasted is not considered to be a choice variable. This might seem restrictive. However, the *maximum* amount of commercials is often regulated by the government and the restrictions are generally binding, at least during prime time. Specifically, this is the case in the EU where there is an nine minute advertising cap per hour.⁴ Note, that in the presence of binding advertising caps there is no need to explicitly take into account the two-sidedness of the market since the nuisance cost will not affect marginal incentives. Finally, firms are assumed to have constant and identical production costs that are normalized to zero.

Let θ^* denote the ideal channel profile of viewers that are indifferent between watching the favorite program type in *C1* and *C2*. Moreover, let θ_L denote the ideal profile of consumers that are indifferent between flipping and sticking to *C1* all evening. The threshold θ_H is similarly defined for *C2*. Then, it follows from expression (1) that

$$\theta^* = \frac{1 + a_1 - a_2}{2} \quad (2)$$

⁴See Anderson (2005). The US used to have a similar regulation based on a voluntary agreement among broadcasters. See Anderson and Gabszewicz (2006). Other studies that rely on perfectly elastic advertiser demand and advertising caps are e.g., Spence and Owen (1977) and Hansen and Kyhl (2001)

$$\theta_L = \theta^* - \frac{S(1-z)}{2t} \quad (3)$$

$$\theta_H = \theta^* + \frac{S(1-z)}{2t}. \quad (4)$$

Obviously, if $z = 1$, so that program types do not matter, consumers have no incentives to flip and $\theta^* = \theta_L = \theta_H$. It is clear that only consumers with low enough time cost will find it worthwhile to watch. *Figure 2* shows the critical time costs for various ideal channel profiles. Let us begin by studying the critical time costs of *C1*'s viewers displayed below.

$$\hat{w}_1 = \begin{cases} S - t(a_1 - \theta) & \theta \in [0, a_1] \text{ watching one program in } C1 \text{ (A)} \\ S - t(\theta - a_1) & \theta \in [a_1, \theta_H] \text{ watching one program in } C1 \text{ (B-F)} \\ zS - t(a_1 - \theta) & \theta \in [0, a_1] \text{ watching two programs in } C1 \text{ (C)} \\ zS - t(\theta - a_1) & \theta \in [a_1, \theta_L] \text{ watching two programs in } C1 \text{ (D)} \\ S - t(1 - a_2 - \theta) & \theta \in [\theta_L, \theta^*] \text{ when flipping (E)} \end{cases} \quad (5)$$

All consumers with ideal profiles belonging to the interval $\theta \in [0, \theta_H]$ will watch at least one program in *C1* if critical time costs are below A-B-F. People for which $\theta \in [0, a_1]$ watch one program if time costs are between A and C and two programs for lower time costs. The same argument applies for viewers with $\theta \in [a_1, \theta_L]$ but here the relevant thresholds are B and D. In the interval $\theta \in [\theta_L, \theta^*]$ consumers with time costs between B and E watch one program in *C1* while viewers with lower time costs flip. Finally, in the interval $\theta \in [\theta^*, \theta_H]$ the preferred channel is *C2* but consumers with time costs below F flip. Hence, the total number of viewer exposures generated by *C1* is given by the area below A and B and F. If the area below E and F is deducted, the remaining part measures the total number of unique viewer exposures. The same arguments apply for *C2*. Intercepts at $\theta = 0$ and $\theta = 1$ are indicated in *Figure 2*.

Let $\overline{w}(\theta)$ denote the function consisting of the upper threshold segments in *Figure 2*. Similarly, let the lower segments be denoted by $\underline{w}(\theta)$. Then,

$$\underline{w}(\theta_L) = \underline{w}(\theta_H) = \frac{S(1+z)}{2} - \frac{t(1-a_1-a_2)}{2} \quad (6)$$

$$\underline{w}(\theta^*) = \overline{w}(\theta^*) = S - \frac{t(1-a_1-a_2)}{2} \quad (7)$$

$$\overline{w}(a_1) = \overline{w}(1-a_2) = S \quad (8)$$

$$\underline{w}(a_1) = \underline{w}(1-a_2) = zS. \quad (9)$$

Throughout this paper we will assume that $S \geq t$. This ensures full coverage in the channel profile dimension. Specifically, if this condition is satisfied, viewers with zero time costs will always watch two programs.

Obviously, the degree of product differentiation is endogenous and the configuration illustrated in *Figure 2* is valid only if differentiation is large enough. As differentiation is reduced, a_1 approaches θ_L and at $\theta_L = a_1$ there is a discontinuity where the viewers below C suddenly become flippers, which in turn means that they no longer generate unique viewer exposures. This discontinuity appears simultaneously for *C2*. As a consequence, both regimes have to be analyzed separately.

The situation when differentiation is "small" is illustrated in *Figure 3*. Here, segments C and D have disappeared while segments E and F intersect with the vertical axes at $\underline{w}(0) = S - t(1-a_2)$ and $\underline{w}(1) = S - t(1-a_1)$ respectively. We will refer to the situation depicted in *Figure 2* as *limited flipping*, denoted by subscript *L*. The situation in *Figure 3* will be referred to as *general flipping*, denoted by subscript *G*.

It is straightforward to show that flipping is limited, as defined above, when $1 - a_1 - a_2 > \frac{S}{t}(1-z)$. This condition is illustrated in *Figure 4* where combinations below the thick line are such that endpoint viewers do not flip. Let us denote the common intercepts by $\psi = 1 - \frac{S}{t}(1-z)$. In order to economize in terms of parameters we define $V \equiv \frac{t}{S}$. Hence, $\psi = 1 - \frac{1-z}{V}$.

As argued above, empirical evidence suggest that the price of commercials is highly related to the type of audience watching when the commercial is broadcasted. In an attempt to capture this empirical regularity, we assume that firms can sell their unique viewer exposures at the price P_U while common viewer exposures are sold at the price P_C , where $P_U \geq P_C$. For simplicity we assume that the willingness to pay for unique viewer exposures is independent of the number of programs watched. Hence, exposing a viewer for a specific commercial once is enough to fully influence behavior.

Channels choose locations in order to maximize revenues from selling commercials. Let D_T , D_U and D_C denote total, unique and common viewer exposures respectively. Then *C1s* profits are simply $\pi_1 = P_U(D_T - D_C) + P_C D_C$. Explicit expressions for the demand functions are accounted for in the Appendix. For notational convenience, we define the relative price $m \equiv P_C/P_U \leq 1$.

Next, we study the equilibria of the two regimes separately, starting with limited flipping.

2.1 Limited Flipping

It is straightforward to state a necessary condition for the existence of equilibria characterized by limited flipping.

Proposition 1: *Equilibria characterized by limited flipping can only occur if transportation costs are above a certain threshold level. Specifically, such equilibria may exist only for $V > V_1 \equiv 1 - z$.*

Proof: For $V < 1 - z$, ψ is negative. Thus, no combination of a_1 and a_2 will prevent endpoint viewers from flipping. **QED**

Let us define an interior equilibrium as an equilibrium configuration (a_1^* and a_2^*) that is strictly below the thick line in *Figure 4*.

Proposition 2: *There exist no interior equilibria characterized by limited flipping.*

Proof: Suppose that an interior equilibrium exists. Maximizing profits yields the following reaction function, $a_i(a_j) = \frac{2m(1-z)+V+z+1}{5V} - \frac{a_j}{5}$, which in turn implies a symmetric equilibrium candidate $a_L^* = \frac{2m(1-z)+V+z+1}{6V}$. However, since $a_L^* - \frac{1}{2}\psi =$

$\frac{2-V-z+2m(1-z)}{3V} > 0$, all intersections between reaction functions lie outside the range for which they are defined. **QED**

Now, if interior equilibria do not exist, it might still be the case that corner solution equilibria exist where endpoint consumers only weakly prefer not to flip, i.e., equilibria along the thick line in *Figure 4*. In that case, the equilibrium configuration must satisfy $1 - a_1 - a_2 = \frac{1}{V}(1 - z)$. Let $\hat{a}_i(a_j) = 1 - a_j - \frac{1}{V}(1 - z)$ be the value of a_i that yields a corner solution for a given value of a_j . It can be shown that for V and z large enough, there always exists an equilibrium range of a_1 s and a_2 s along $\hat{a}_i(a_j)$, i.e., along the thick line.

Proposition 3: If transportation costs are high, in the sense that $V > V_2 \equiv \frac{2(1-z)}{1-m}$ (where $V_2 > V_1$) there exists an equilibrium range of a_1 s and a_2 s along $\hat{a}_i(a_j)$. Specifically, the equilibrium configuration is given by $a_i^* = \hat{a}_i(a_j^*)$ and $a_j^* \in [\frac{1}{2}\psi \pm \min[\frac{1-V+(1-z)(1+m)}{2V}, \frac{V(1-m)-2(1-z)}{2V(1+m)}]]$.

Proof: For $a_1 = \hat{a}_1(a_2)$ to be a best response, it must be the case that $\frac{\partial \pi}{\partial a_1} < 0$ given the demand structure under general flipping at the same time as $\frac{\partial \pi}{\partial a_1} > 0$ under limited flipping. The first condition is equivalent to $a_2 < \bar{a} \equiv \frac{2V-(1-z)(3+m)}{2V(1+m)}$ while the second condition is equivalent to $a_2 > \underline{a} \equiv \frac{2V+2z-3-m(1-z)}{2V}$. The parameters $\underline{a}$ and $\bar{a}$ are the same for both channels. A corner solution equilibrium will only exist if the intervals overlap. Hence, a necessary and sufficient condition for the existence of a corner solution equilibrium is $\underline{a} < \frac{1}{2}\psi < \bar{a}$. This condition is satisfied for $V_2 < V < 1 + (1 - z)(1 + m)$. Obviously, the second inequality is always satisfied since $V \equiv t/S < 1$ by assumption. This proves the first part of the proposition. If $\hat{a}_2(\bar{a}) < \underline{a}$, then best response functions overlap for $a_2 \in [\underline{a}, \hat{a}_2(\underline{a})]$ which translates into the first argument behind the min-operator (See *Figure 5*). If $\hat{a}_2(\bar{a}) > \underline{a}$ best response functions overlap for $a_2 \in [\hat{a}_2(\bar{a}), \bar{a}]$ which translates into the second argument behind the min-operator (See *Figure 6*). **QED**

Let us now turn to the case of general flipping.

2.2 General Flipping

Flipping is general, as defined above, when $1 - a_1 - a_2 < \frac{S}{t}(1 - z)$. In *Figure 4* combinations above the thick line are such that endpoint viewers flip. Let us first state a necessary condition for the existence of equilibria characterized by general flipping. Under the demand structure characterized by general flipping (See the Appendix), profits are strictly concave in a_1 . Differentiating with respect to a_1 we arrive at the following reaction function

$$a_1(a_2) = \frac{1 + m - (1 - m)a_2}{3 + m}. \quad (10)$$

Firstly, we may conclude that locations are strategic substitutes unless prices are uniform. Intuitively, if $P_C = P_U$, it does not matter for *C1* whether or not a certain viewer watches *C2* as well. Hence, firms are just interested in maximizing total viewership and the locational choice made by the competitor becomes strategically irrelevant. When prices differ, firms will want to keep a certain amount of product differentiation in order to attract a partially unique audience. Secondly, the equilibrium will only depend on *relative* prices in the market for commercials. No policy that affect other parameters of the model will affect the market outcome, nor will policies that affect prices in a proportionate way. Solving for the symmetric equilibrium we arrive at

$$a_G^* = \frac{1 + m}{4}. \quad (11)$$

Proposition 4: *The equilibrium under general flipping depends solely on conditions in the market for commercials. Specifically, it depends on the relative price of common vs unique viewer contacts.*

Finally, we must characterize the conditions under which the proposed equilibrium exists and is stable.

Proposition 5: *An equilibrium characterized by general flipping can only occur if transportation costs are low. Specifically, such equilibria may exist only for $V < V_2$.*

Proof: For $V > V_2$, $a_G^* < \frac{1}{2}\psi$. Hence, the equilibrium location is not consistent with the demand specification under which it was derived. **QED**

When advertising rates differ a lot there exists a parameter range for which no pure strategy equilibrium exists.

Proposition 6: For $m \in [0, \frac{1}{2}]$ there exists a threshold value $\hat{V}$ such that a_G^* is unstable for $V \in [\hat{V}, V_2]$. For $m \in [\frac{1}{2}, 1]$, a_G^* is stable for all $V \in [0, V_2]$.

Proof: Let us define a deviation as a situation when CI reduces a_1 to such an extent that there is a change in regime from general flipping to limited flipping. For a deviation to be possible it must be the case that $a_G^* < \psi$. This is equivalent to $V > V_3 \equiv \frac{4(1-z)}{3-m}$. It can easily be checked that $V_2 > V_3$ for $z < 1$. Let π^* denote the profit under the symmetric equilibrium when locations are $a_1 = a_2 = a_G^*$. Let π^D denote CI 's deviation profit when $a_2 = a_G^*$ and $a_1 = \hat{a}_1(a_G^*)$. In the latter case, the relevant demand specification is that of limited flipping. Finally, let $\Delta\pi \equiv \pi^D - \pi^*$ and let $\hat{V}$ be the value of V for which $\Delta\pi = 0$ (See the Appendix). It can be checked that there is no value of m for which $\hat{V}$ and V_2 intersect. However, the functions $\hat{V}$ and V_2 are identical for $m = \frac{1}{2}$. It can be verified that $\hat{V} < V_2$ for $m < \frac{1}{2}$ and that $\hat{V} > V_3$ for $z < 1$. Hence, only for $m \in [0, \frac{1}{2}]$ it will be the case that $V_3 < \hat{V} < V_2$. **QED**

3 Results

Propositions (3), (5) and (6) can be summarized in two simple graphs. *Figures 7 and 8* show combinations of V s and z s that are compatible with equilibria characterized by general and limited flipping respectively. Parameter combinations within the area surrounded by dashed lines permit the existence of a unique symmetric interior solution equilibrium characterized general flipping. For parameters restricted by solid lines there exist multiple corner solution equilibria characterized by limited flipping. For $m < 1/2$ there is also a range of parameters between $\hat{V}$ and V_2 for which no pure strategy equilibrium exists i.e., the area marked with diagonal lines in *Figure 7* (See *Proposition 6*). Basically, there are two counteracting effects determining the

types of equilibria that may emerge. First, there is a *business stealing effect*. By reducing the degree of differentiation, a channel can attract additional viewers from the competing channel, thereby creating more revenues from commercials. Second, there is a *unique viewer effect*. By increasing differentiation a channel can trigger a discrete jump in the the number of unique viewer exposures, which may increase profits if sold at a high price. If transportation costs are low (i.e., if V is low) and if the perceived quality difference between program types is high (i.e., if z is low), it is easy to attract new viewers. Hence, the business stealing effect will dominate and the only possible equilibrium is that of general flipping. High transportation costs in combination with small quality differences between program types makes business stealing less appealing. Hence, the unique viewer effect dominates which, in turn, leads to a situation where the only feasible equilibria are characterized by limited flipping. The scope for limited flipping equilibria is reduced as advertising prices P_U and P_C become more similar and as m approaches unity it disappears completely. Protecting unique viewer exposures simply becomes pointless if they do not generate additional revenues. These results are summarized in the following proposition.

Proposition 7: *When transportation costs are high and quality differences between program types are small, there exist multiple equilibria characterized by limited flipping. If opposite relations hold, there is a unique symmetric equilibrium characterized by general flipping. If advertising prices are very different ($m < 1/2$) there also exists an intermediate range of V s and z s such that no pure strategy equilibrium exists. The scope for equilibria characterized by limited flipping is larger, the larger the advertising price premium for unique viewer contacts. If prices are equal, limited flipping can no longer be an equilibrium outcome.*

Let us now turn to the welfare implications of the model. Throughout the section, we abstract from effects on related markets such as the potentially beneficial effects of informative advertising. Since advertiser demand is assumed to be perfectly elastic we also abstract from effects on producers' surplus. In order to compare welfare under different types of equilibria it is necessary to derive expressions for aggregate consumer welfare given arbitrary locations in terms of channel profiles. Let W_G and

W_L denote welfare under general flipping and limited flipping respectively. Explicit expressions can be found in the Appendix. The main welfare results are summarized in Proposition (8). It turns out that minimum differentiation maximizes welfare unless consumers have weak preferences over program types.⁵

Proposition 8: *For $z \in [0.707, 1]$ there exists a critical value V_4 such that consumer welfare is maximized for $a_i = a_j = a^{**} = 1/2$ if $V < V_4$ while for larger values of V , welfare is maximized for $a_i = a_j = a^{**} = \frac{z^2 - 2z(1-V) - V^2 + 2V + 1}{4V(2z - V + 2)}$ which decreases in z and approaches $1/4$ as z approaches 1. In the former case welfare maximization implies general flipping while in the latter case it implies limited flipping. For $z \in [0, 0.707]$ welfare is always maximal for $a_i = a_j = a^{**} = 1/2$.*

Proof: Note that W_G and W_L are strictly concave in $a_i = a_j = a$. The result follows from maximizing W_G and W_L with respect to a and comparing maximized welfare levels. The critical value V_4 is implicitly defined by the following condition: $V^4 - 8V^3 - 2V^2(5z^2 - 2z - 11) - 8V(1-z)(z^2 + 4z + 3) - (1-z)(9z^3 + 5z^2 - 5z - 9) = 0$. It is evident that $a_i = a_j = 1/2$ is always consistent with the demand structure behind W_G . In case welfare maximization implies limited flipping, $a^{**} < \frac{1}{2}\psi$ if $V > 2 - \sqrt{3z^2 + 2z - 1}$ which is always satisfied for $V > V_4$. This concludes the proof.

QED

The critical value V_4 is plotted in *Figure 9* where parameters to the left of the thick line imply that $a^{**} = 1/2$. In order to provide a feeling for the relation between optimal channel profiles (a^{**}) and equilibrium channel profiles (a^*) the results obtained in propositions (3), (4) and (8) are illustrated in *Figure 10*. When multiple equilibria exist, the symmetric average location, $\frac{1}{2}\psi$, is depicted. Although the figure is drawn for specific parameters ($V = 0.8$ and $m = 0.5$) it provides a general picture

⁵The welfare measures are derived in the following way: $W_G = \int_0^{\hat{w}_1} \int_0^{a_1} [S - w - t(a_1 - \theta)] dw d\theta + \int_0^{\hat{w}_1} \int_{a_1}^1 [S - w - t(\theta - a_1)] dw d\theta + \int_0^{\hat{w}_2} \int_0^{1-a_2} [S - w - t(1 - a_2 - \theta)] dw d\theta + \int_0^{\hat{w}_2} \int_{1-a_2}^1 [S - w - t(\theta - 1 - a_2)] dw d\theta$ where $\hat{w}_2$ is defined in analogy with equation (5). Under limited flipping the corresponding welfare measure is slightly more complex. $W_L = \int_0^{\hat{w}_1} \int_0^{a_1} [S - w - t(a_1 - \theta)] dw d\theta + \int_0^{\hat{w}_1} \int_{a_1}^{\theta_H} [S - w - t(\theta - a_1)] dw d\theta + \int_0^{\hat{w}_1} \int_0^{a_1} [zS - w - t(a_1 - \theta)] dw d\theta + \int_0^{\hat{w}_1} \int_{a_1}^{\theta_L} [zS - w - t(\theta - a_1)] dw d\theta + \int_0^{\hat{w}_2} \int_{\theta_L}^{1-a_2} [S - w - t(1 - a_2 - \theta)] dw d\theta + \int_0^{\hat{w}_2} \int_{1-a_2}^1 [S - w - t(\theta - 1 - a_2)] dw d\theta + \int_0^{\hat{w}_2} \int_{\theta_H}^{1-a_2} [zS - w - t(1 - a_2 - \theta)] dw d\theta + \int_0^{\hat{w}_2} \int_{1-a_2}^1 [zS - w - t(\theta - 1 - a_2)] dw d\theta$.

from a qualitative point of view. Intuitively, one might think that the socially efficient degree of product differentiation would always be $a_1 = a_2 = 1/4$ since these locations are likely to minimize average transportation costs. This is a standard result in the literature. See e.g., Anderson and Gabszewicz (2006). This is true also in our model, but only for $z = 1$, i.e., the case when there is only one program type. The stronger the preference for program types, the more consumers flip. This, in turn, reduces the optimal degree of product differentiation. When the number of flippers is large, transportation costs are minimized at $a_1 = a_2 = 1/2$. Equilibrium locations follow a very different pattern. For $z = 1$ we get the standard result that market forces (i.e., business stealing incentives) lead to minimum differentiation. However, the smaller z is, the stronger the incentives to flip. In order to off-set these incentives, channels increase differentiation, thereby keeping the number of unique viewer exposures up. Obviously, policies aimed at increasing differentiation is a good thing only if viewers have weak preferences over program types. If preferences are strong, the market solution tends to be characterized by *excessive* differentiation. To explain why our results differ from the standard Hotelling (1929) type of model predictions, note that in our model consumers with low time costs end up watching *both* channels regardless of firm locations and preferences.

The equilibria for large z s do not depend on conditions in the market for commercials. However, when consumers have strong preferences over program types, the market for commercials plays a crucial role.

Proposition 9: *Suppose that consumers have strong preferences over program types so that z is small. Then, the socially optimal solution coincides with the market solution only if all consumers exposures are valued the same (i.e., if $m = 1$). For $m \neq 1$, the market outcome is characterized by excess product differentiation. The greater the price differential the more inefficient is the market solution.*

One implication of Proposition (9) is that the development of technologies that allow for targeted advertising (i.e., differentiated advertising rates) may have lead to a shift from a socially optimal situation to one characterized by excessive product differentiation.

It is easy to see that a *mixed* market solution would coincide with the socially optimal solution given that consumers have strong preferences over program types. Suppose that there is a public service channel (*C1*) competing with a commercial channel (*C2*) and that the public service channel has the objective to maximize aggregate viewer utility. Then the best choice of (*C1*) would be $a_1 = 1/2$. The reason is that if there is just one commercial channel, all viewer exposures would be unique so there is no reason why P_U and P_C would differ. Hence, the best response to $a_1 = 1/2$ would be $a_2 = 1/2$. This leads us to our final proposition.

Proposition 10: *Suppose that consumers have strong preferences over program types so that z is small. Then, the mixed market equilibrium coincides with the socially optimal equilibrium.*

4 Concluding remarks

We may conclude that policies aimed at increasing diversity is beneficial only when viewers care little about program content. If viewers care a lot, differentiation should be reduced. One way of accomplishing this is to support public service channels financed by means other than advertising. From a more general perspective, the evolution of targeted advertising may have been detrimental to welfare. If all advertising exposures were paid the same, as in the "old days", there would be no reason to protect unique exposures. Hence, the only possible market outcome is that of general flipping. Keeping the assuming a uniform advertising rate we then know that the market outcome is socially efficient.

Appendix

The number of viewer contacts under limited flipping:

$$D_C = \frac{t}{4V^2}(1-z)(3+z-2V(1-a_1-a_2))$$

$$D_T = \frac{t}{8V^2}(3-V^2(1-a_2)^2+2V(1-a_2)(a_1V+z+1)-5a_1^2V^2+2a_1V(3-z)-z^2-2z)$$

The number of viewer contacts under general flipping:

$$D_C = \frac{t}{4V}(4-3V-a_1^2V+2a_1V(1+a_2)-a_2^2V+2a_2V)$$

$$D_T = \frac{t}{2V}(2-V(2a_1^2-2a_1+1))$$

The critical value of V for stability of the equilibrium under general flipping:

$$\hat{V} = \frac{2[2(z(m-3)-6(m-1))-\sqrt{2}q]}{7m^2-26m+15}$$

where

$$q = \sqrt{-z^2(21m^3-73m^2+31m-3)+2z(7m^3-17m^2-15m+9)+7m^3+11m^2+m-3}$$

Aggregate consumer welfare:

$$W_G = \frac{t^2}{6V^2}(3V(2-V)(a_1(1-a_1)+a_2(1-a_2))+2(V^2-3V+3))$$

$$W_L = \frac{t^2}{12V^3}(\alpha V^3 - \beta V^2 + \delta V + \gamma)$$

where

$$\alpha = 3a_1^3 + 3a_1^2(1-a_2) - 3a_1(a_2^2 - 2a_2 + 1) + 3a_2^3 + 3a_2^2 - 3a_2 + 1$$

$$\beta = 3(1+z)(3a_1^2 - 2a_1(1-a_2) + 3a_2^2 - 2a_2 + 1)$$

$$\delta = 3((1-z)^2(a_1+a_2) + z^2 + 2z + 1)$$

and

$$\gamma = (1+z)(1-z)^2.$$

Endogenous TV listings:

Assume that an initial stage is introduced when channels choose whether or not to differentiate their TV listing. First, suppose that they choose identical TV listings. Then, no viewer will have an incentive to flip which, in turn, makes all viewer exposures unique. Let us keep the assumption that the advertisers' marginal valuation of a second exposure is zero. Consequently, all viewer contacts are paid the same regardless if one or two programs are watched. This means that $C1$'s demand would equal the area below segments A and B in *Figure 2*. Profits would then

equal $\pi_1 = P_U D_1 = P_U \frac{t}{8V} (4(1 + a_1 - a_2) - V(5a_1^2 - 2a_1(1 - a_2) + (1 - a_2)^2))$ where D_1 is the total number of viewers watching *C1*. It is straightforward to check that equilibrium channel profiles are then $a_1 = a_2 = 1/2$ which, in turn, implies symmetric profit levels, $\pi_N = \frac{P_U t(4-V)}{8V}$ where subscript N denotes "no flipping". Let us now compare these profits to symmetric profits under limited flipping, π_L , and general flipping, π_G . In the latter case equilibrium channel profiles are given by expression (11). Inserting these into the profit function $\pi_G = P_U(D_T - D_C) + P_C D_C$, where demand functions are accounted for above, and comparing profits we get that $s(\pi_G - \pi_N) = s(V(3m^2 - 10m + 5) + 8(2m - 1))$. This function increases in m and is positive for $m > \frac{1}{3V}(\sqrt{2(5V^2 - 28V + 32)} + 5V - 8) \equiv \tilde{m}$. The critical value $\tilde{m}$ is decreasing in V and ranges from $1/2$ (for V approaching zero) to $\sqrt{2} - 1 \approx 0.41$ for $V = 1$. Hence, unless unique viewer contacts are paid twice as much as common contacts, TV listings will be differentiated.

Similar results apply when the point of reference is limited flipping. Since there are multiple equilibria in this case, let us focus on the symmetric equilibrium where $a_1 = a_2 = 1/2\psi$. Inserting this into the profit function $\pi_L = P_U(D_T - D_C) + P_C D_C$, where demand functions are accounted for above, and comparing profits we get that $s(\pi_L - \pi_N) = s(z(6m - 1) + 2m + 2V - 3)$. This function increases in m and is positive for $m > \frac{z-2V+3}{2(3z+1)} \equiv \hat{m}$. The problem is to find the maximal value of m that is consistent with limited flipping ($V > V_2$) and for which identical TV listings are optimal from the firms' point of view ($m < \hat{m}$). For $z \in [0, \frac{1}{8} + \frac{\sqrt{17}}{8}]$ all parameters that allow for limited flipping equilibria also imply that $m < \hat{m}$. Then, from the definition of V_2 it follows that m cannot be larger than $m = \frac{\sqrt{17}}{4} - \frac{3}{4} \approx 0.28$. For $z \in [\frac{1}{8} + \frac{\sqrt{17}}{8}, 1]$ the largest value of m that is consistent with limited flipping and identical TV listings is $m = 1/2$. This value is reached for $m = \hat{m}$, $V = V_2$ and $z = 1$. Hence, again, unless unique viewer contacts are paid twice as much as common contacts, TV listings will differ in equilibrium.

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Figures

Figure 1

CPT as a function of viewing time (Kanal 5)

Figure 2 (Limited flipping)

Figure 3 (General flipping)

Figure 4 (Potential equilibria)

Figure 5 (Corner solution equilibria 1)

Figure 6 (Corner solution equilibria 2)

Figure 7 (Critical values for equilibria when $m=0.3$)

Figure 8 (Critical values for equilibria when $m=0.7$)

Figure 9 (Critical values for welfare)

Figure 10 (Optimal and equilibrium profiles for $m=0.5$, $V=0.8$)

Table 1

Raw correlations between CTP and Time

<i>All</i>	<i>TV3</i>	<i>TV4</i>	<i>Kanal 5</i>	<i>Discovery</i>
-0,23	-0,61	-0,48	-0,07	-0,69

Table 2*Average time watching TV, for different genders and age cohorts (minutes per 24 hours)*

	Total	Men	Women	3-14	15-24	25-39	40-59	60+
All	157	151	163	100	93	156	166	217
TV3 gr.	22	21	23	12	23	30	23	18
TV4 gr.	41	35	47	13	19	38	48	62
Kanal 5 gr.	13	11	15	7	16	22	12	8
Discovery	3	4	2	1	3	4	4	2
Publ.serv.	50	47	52	22	13	31	50	101
Others	28	33	24	45	19	31	29	26

Average time watching TV for different genders and age cohorts (percentage terms)

	Total	Men	Women	3-14	15-24	25-39	40-59	60+
TV3 gr.	0,14	0,14	0,14	0,12	0,25	0,19	0,14	0,08
TV4 gr.	0,26	0,23	0,29	0,13	0,20	0,24	0,29	0,29
Kanal 5 gr.	0,08	0,07	0,09	0,07	0,17	0,14	0,07	0,04
Discovery	0,02	0,03	0,01	0,01	0,03	0,03	0,02	0,01
Publ.serv.	0,32	0,31	0,32	0,22	0,14	0,20	0,30	0,47
Others	0,18	0,22	0,15	0,45	0,20	0,20	0,17	0,12

Average minutes per day watched by different genders and age cohorts

Ages	Men	Women	All
3-11	104	94	99
12-24	84	107	95
12-59	140	147	143
15-29	102	120	111
15-34	117	134	125
15-39	128	135	131
15-44	134	138	136
15-49	138	140	139
20-29	110	137	123
20-34	128	149	138
20-39	139	147	143
20-44	143	147	145
25-34	153	161	157
25-39	158	154	156
25-44	159	154	156
25-49	159	153	156
25-59	161	161	161

Average cost per thousand (CPT in SEK) for the TV3 group (prime time) 2007

Ages	Men	Women	All
3-11			
12-24	834,00	692,00	903,00
12-59			
15-29			
15-34	1230	1101	525
15-39			
15-44	1897	1721	371
15-49			
20-29			
20-34			
20-39	1220	1105	530
20-44	1549	1431	435
25-34			
25-39			
25-44	1247	1191	552
25-49			
25-59	2120	2095	354

Average cost per thousand (CPT in SEK) for the TV4 group (prime time) 2007

Ages	Men	Women	All
3-11			
12-24			
12-59			240
15-29			
15-34			
15-39	1129	1183	557
15-44			
15-49			
20-29			
20-34			
20-39			
20-44	1006	961	484
25-34			
25-39			
25-44			
25-49			
25-59	648	598	316

Average cost per thousand (CPT in SEK) for the Kanal 5 group (prime time) 2007

Ages	Men	Women	All
3-11			
12-24			874
12-59			780
15-29			
15-34	1104	1190	572
15-39			
15-44	712	762	368
15-49	614	652	316
20-29	2360	2513	1217
20-34	1512	1606	778
20-39	1091	1169	564
20-44	861	914	443
25-34	2247	2304	1138
25-39	1428	1500	731
25-44	1058	1104	540
25-49	856	886	436
25-59	615	628	310

Average cost per thousand (CPT in SEK) for Discovery (prime time) 2007

Ages	Men	Women	All
3-11			
12-24			
12-59			
15-29			
15-34	425		340
15-39			
15-44			
15-49	236		150
20-29			
20-34			
20-39			
20-44	254		208
25-34			
25-39			
25-44			
25-49			
25-59	260		195