Sieg, Gernot; Rothbauer, Jula

Conference Paper

Welfare Effects of Public Service Broadcasting in a Free-to-Air TV Market

Beiträge zur Jahrestagung des Vereins für Socialpolitik 2013: Wettbewerbspolitik und Regulierung in einer globalen Wirtschaftsordnung - Session: Media und Platform Competition, No. G13-V3

Provided in Cooperation with:

Verein für Socialpolitik / German Economic Association

Suggested Citation: Sieg, Gernot; Rothbauer, Jula (2013) : Welfare Effects of Public Service Broadcasting in a Free-to-Air TV Market, Beiträge zur Jahrestagung des Vereins für Socialpolitik 2013: Wettbewerbspolitik und Regulierung in einer globalen Wirtschaftsordnung - Session: Media und Platform Competition, No. G13-V3, ZBW - Deutsche Zentralbibliothek für Wirtschaftswissenschaften, Leibniz-Informationszentrum Wirtschaft, Kiel und Hamburg

This Version is available at:
https://hdl.handle.net/10419/79800

Welfare Effects of Public Service Broadcasting in a Free-to-Air TV Market

Julia Rothbauer and Gernot Sieg
WWU Münster
CAWM
Am Stadtgraben 9
48143 Münster
Germany
gernot.sieg@uni-muenster.de
Fax: +49 251 83 28395

June 27, 2013

Abstract

In a two-sided free-to-air TV market with two differentiated private channels the market entry of a commercial free Public Service Broadcaster (PSB) broadcasting both information-type and show-type content may enhance welfare. Welfare may rise because information consumption of TV viewers generates external benefits for society by improving the ability of voters to control politicians and because the equilibrium amount of commercials may be inefficient. A PSB only improves welfare if it's cost are not to high, the external benefits of voter information are rather large and the informational value of commercials is rather low.

JEL: L82; D72; L32

Keywords: Media, two-sided TV market, information externalities

1 Introduction

Australia and most European countries have a TV market that consists of both private and public service broadcasters (PSBs). One of the main Australian Broadcasting Corporation's function is "to provide (i) broadcasting programs that contribute to a sense of national identity and inform and entertain, and reflect the cultural diversity of the Australian community" (Australian Broadcasting Corporation Act 1983 - Sect 6, (1) (a) (i)). In Europe, the mandate of the PSBs is within the competence of the Member States but they share the opinion that PSB "has an important role to play in promoting cultural diversity in each country, in providing educational programming, in objectively informing public opinion, in guaranteeing pluralism and in supplying, democratically and free-of-charge, quality entertainment" (Oreja, 1998). The Australian and the European PSBs offer a wide range of programs, including predominantly entertainment content.

An ideal PSB is usually seen as provider of universal service, as independent from government and vested interests, serving interest of minorities including children, reflecting national culture and providing programming not driven by audience size (Franklin, 2001; Debrett, 2009). The provision of entertainment content is not in this list. Usually, entertainment content is not in short supply but comprehensively broadcasted by private channels. Furthermore, most PSBs have recently expanded their activities to the provision of internet content. This has triggered a new debate about the eligibility of public service broadcasting (of entertainment content) in a digital world (Armstrong, 2005; Hargreaves Heap, 2005; Armstrong and Weeds, 2007; Commission, 2009).

With regard to analog technology (large barriers to entry), economists have identified several justifications for state intervention in the TV market, most of which are not applicable to the broadcasting technology available today (small barriers to entry). However, some arguments still apply and we look at two of them, the external benefits of information consumption and the possibility of under- or oversupply of commercials.

Information consumption generates not only positive private utility but also external benefits to society (Downs, 1957; Armstrong, 2005; von Hagen and Seabright,

2007). The selection and monitoring of politicians can be viewed as a principal-agent problem, with voters as principals and politicians as agents. Media coverage of politicians and policies increases the level of voter information with respect to current issues. This increases the responsiveness of voters to alternative policies and thereby the effort and selection of politicians (Prat and Strömberg, 2011). Thus, information consumption by voters results in better policies.

However, consuming information via TV channels involves a private decision made by each voter. Voters consider the private costs of subscribing to a channel, which is zero if it is a free-to-air channel, and the opportunity costs of the time spent watching the program with commercial breaks. Conversely, voters benefit from the entertainment value of a TV program and the additional private benefit they derive from informed voting if the program is informative. The rational voter does not consider the external benefit of information consumption to all other citizens. The information consumption of each voter is therefore socially suboptimal, or as Downs (1957, p. 246) writes: "(1) rational citizens want democracy to work well so as to gain its benefits, and it works best when the citizenry is well-informed; and (2) it is individually irrational to be well-informed."

As well, the amount of commercial broadcasting time a free market provides can be socially suboptimal. On private free-to-air-channels viewers have to spent time watching commercials in order to watch content. The opportunity cost of time, or nuisance cost of commercials, must be balanced against the benefits of advertisers from viewers buying their product. In the unregulated market, the amount of commercials is a private decision of profit maximizing TV stations. As Anderson and Coate (2005) and Kind et al. (2007) show, this amount has not to be welfare maximizing.

To answer the question whether PSB is still sensible in the digital world we compare the situations with and without PSB. In many countries, for example Australia and the U.K., a commercial free PSB that broadcasts as well information-type as show-type content competes with differentiated private TV channels funded by commercials. To analyze such a market, we start with a duopoly of differentiated private free-to-air TV channels and study the market entry of a public

service channel broadcasting a mix of information-type and show-type content but no commercials. Although public service broadcasting presumably provides positive welfare effects through the provision of additional informational content, it could also cause losses of rents in the private broadcasting industry. Advertisers will no longer reach viewers who prefer to watch the commercial free public service channel. We determine the reactions of private channels and advertisers in the two-sided TV market and identify the conditions for which market entry or exit by the public service channel is welfare-enhancing.

Several studies of the broadcasting market have focused on different market structures and failures. Anderson and Coate (2005) carry out a welfare analysis of a broadcasting market, but focus on the market outcomes of commercial broadcasting. They are interested in whether there is over- or underprovision of commercials and over- or under-provision of programs. We examine the external effects of the consumption of informational content, which they do not consider. However, we follow the seminal paper of Anderson and Coate (2005) in many respects.

Choi (2006) analyzes market entry in the broadcasting industry and aligned market failure by considering the entry decisions of private channels that compete for viewers and commercial revenues. We analyze the market entry of a public service TV channel that is not interested in commercial revenues and does not broadcast commercials. However, the public service channel attracts viewers and therefore reduces the revenues of private channels. By assuming free channel entry and exit, Choi (2006) determines the optimal number of channels and detects the market failures related to the over- and under-provision of channels. We do not allow for entry and exit of private channels but consider a viable duopoly in the analysis of the entry and exit of a public service channel.

Kind et al. (2007) analyze a public service TV channel that can partly correct market distortions. Similar to our approach, they analyze a mixed oligopoly of one public service channel and two private free-to-air channels. The aim of the public service channel is to correct for the inefficient level of advertising in the unregulated private channel duopoly by broadcasting commercials. They do not

consider the external effect of information consumption on welfare. Furthermore, we analyze PSBs that are not allowed to use the policy instrument of broadcasting commercials.

Prat and Strömberg (2005) compare a public monopoly and a mixed duopoly with one PSB and one private broadcaster. The public service channel is journalistically independent, but the government influences the amount of resources available to the PSB and whether news coverage should be tailored to specific socioeconomic groups to improve its re-election probability. Whereas Prat and Strömberg (2005) assume that the design of incentives for the PSB is driven by the re-election efforts of politicians, we analyze the market outcomes and welfare associated with a broad variety of public service program policies and determine the characteristics of a welfare-maximizing policy.

2 Model

There are two types of TV programs. First, a TV channel may broadcast entertainment content, i.e., movies, dramas, music, comedy, sports, and shows, we will refer to as show-type content and for which the broadcasting time is denoted by $t_s \in [0,1]$. Second, a TV channel may broadcast information-type content, such as newscasts and features about science or economics, for which the broadcasting time is denoted by $t_{inf} \in [0,1]$. Finally, a TV channel may broadcast commercials, for which the broadcasting time is denoted by $t_a \in [0,1]$. Total broadcasting time is normalized to 1, such that $t_s + t_{inf} + t_a = 1$. The production costs of both types of content as well as those of commercials do not differ, such that broadcasting of one unit of time costs c_{pr}.

The number of consumers is normalized to 1, and each consumer watches at most one channel per unit of time. Voters are heterogeneous in their preferences for show-type and information-type content. The preference parameter $\lambda \in [0,1]$ is uniformly distributed. The utility that voter λ obtains from TV consumption is denoted by

$$U_\lambda = \lambda \cdot t_s + (1-\lambda) \cdot t_{inf}. \tag{1}$$

The ratio of marginal utilities is constant for a given viewer λ. This means that viewer λ strictly prefers one type of program. If channels broadcast the same amount of non-commercial content, then all consumers with $\lambda < 1/2$ prefer the channel that broadcasts more information-type content, whereas all consumers with $\lambda > 1/2$ prefer the channel that broadcasts more show-type content. Consumers with a constant ratio of marginal utilities single home, a behavior used in our model and one that is widely used following the seminal paper by Anderson and Coate (2005). We do not consider the direct nuisance cost of advertisements but assume that the utility from watching commercials is zero. However, because consumers watch a channel for a constant period of time, the broadcasting time of commercials reduces the consumption of information-type or show-type content. Therefore, each viewer suffers nuisance opportunity costs of commercials of $\max\{\lambda, 1-\lambda\} \cdot t_a$.

We consider advertising that informs consumers about new products that they would buy if they were aware of them (Grossman and Shapiro, 1984). Following Choi (2006, p. 190), let the inverse demand for commercials per viewer be

$$p(t_a) = a \cdot t_a^{-\beta}, \tag{2}$$

where t_a is the broadcasting time for commercials, $0 < \beta < 1$ is the constant elasticity, and $a > 0$ represents the benefit that informative advertising provides to advertisers.[1] Following Anderson and Coate (2005), the consumer surplus for actually buying the advertised product is assumed to be zero. Revenues per viewer are $R(t_a) = p(t_a) \cdot t_a$. The viewer base v of a channel is not fixed but changes due to competition from other channels, depending on advertising levels and program type.[2] Free-to-air channels maximize profits

$$\Pi(t_a) = p(t_a) \cdot t_a \cdot v - c_{pr}. \tag{3}$$

[1]The inverse demand per viewer function used by Anderson and Coate (2005) differs in their special form to the inverse demand function we adopted from Choi (2006, p. 190). However, both functions are log concave with decreasing per viewer marginal revenue.

[2]Because we assume that the market is covered in any case, v can also be interpreted as the market share.

Because consumers are single-homing, broadcasting stations hold monopoly power over access to their viewers. The per viewer surplus of advertisers from advertising t_a units of time is represented by

$$\int_0^{t_a} p(t)dt. \tag{4}$$

Because consumers prefer content to commercials, a channel may attract the attention of its rival's audience by reducing broadcasting time for commercials. If both channels broadcast the same content, then the channel with fewer commercials attracts all the viewers. However, a reduction in commercials jeopardizes revenues. Gabszewicz et al. (2004) and Peitz and Valletti (2008) model this type of advertising competition and show that, to mitigate this Bertrand-like competition, channels reinforce program differentiation. We use this result in our model by assuming that the two TV channels are maximally differentiated: a show channel that broadcasts show-type content and commercials only, and an information channel that does not broadcast show-type content, but information-type content and commercials.

The consumption of information-type content creates an external effect because information consumption by voters "increases the responsiveness of voters to policy, which increases the effort and selection of politicians, producing better policies" (Prat and Strömberg, 2011, p. 30), an effect that single voters only partly consider when choosing which TV channel to watch. The external effect is modeled following Rothbauer and Sieg (2013), by normalizing the pre-TV information level of each voter to zero, such that a positive level of information is only reached by watching information-type content on TV. Therefore, a voter who watches channel ch possesses $I_\lambda = t_{inf}^{ch}$ information. We call the output of information on (better) policies Y and assume that information I is the only factor of production. Owing to universal suffrage, each voter equally influences the production of Y through his or her consumption of information; that is, two voters, $\lambda, \kappa \in [0,1]$, who consume the same amount of information, $I_\lambda = I_\kappa$, have the same marginal product, $\partial Y/\partial I_\lambda = \partial Y/\partial I_\kappa$. Therefore, there is a function $g : [0,1] \to \mathbb{R}$ such that $Y = \int_0^1 g(I_\lambda)d\lambda$. We assume that marginal information consumption has a

non-negative effect on Y because policies improve when citizens are well-informed. Furthermore, we allow for a diminishing marginal product of information consumption. A minute of additional information-type content may be much more useful for a voter who is quite uninformed than for a voter who already has a large stock of information. We define the social output of information as

$$Y = \int_0^1 I_\lambda^\alpha d\lambda, \tag{5}$$

where $0 < \alpha \leq 1$ determines how quickly the marginal productivity of information consumption decreases.

3 Market equilibria

3.1 Duopoly of two private channels

In the Nash equilibrium of the duopoly, both private channels maximize profits (equation (3)) through the optimal choice of commercial broadcasting time t_a sold to advertisers. Private channels sell time t_a for a price $p(t_a)$ according to equation (2). The price a channel may charge is independent of the time the competing channel is offering, whereas channels compete over market share of viewers. An increase in commercial time decreases the utility a consumer receives from viewing and may prompt him to switch to the other channel. If the commercial broadcast time is t_{as} for the show channel and t_{ai} for the information channel, then viewer $\tilde{\lambda} = (1 - t_{ai})/(2 - t_{ai} - t_{as})$ is indifferent between the channels. Therefore, $v_i = \tilde{\lambda}$ viewers watch the information channel and $v_s = 1 - \tilde{\lambda}$, watch the show channel. Assuming a given commercial time for the competing channel, channels maximize profits according to $\Pi_j = v_j \cdot p(t_{aj}) \cdot t_{aj}$, $j \in \{i, s\}$. The best response function for the information channel is

$$t_{ai}^b = \frac{3 - t_{as}}{2} + \frac{1 - t_{as} - \sqrt{(1 - t_{as})\left(8 - (8 - \beta)\beta - (2 - \beta)^2 t_{as}\right)}}{2(1 - \beta)} = t^b(t_{as}), \tag{6}$$

and analogously for the show channel, $t_{as}^b = t^b(t_{ai})$.

In the Nash equilibrium of the duopoly, the broadcasting time for commercials is

$$t_{ai}^{+} = t_{as}^{+} = 1 - \frac{1}{3-2\beta}. \tag{7}$$

The broadcasting time for non-commercial programs is

$$t_{i}^{+} = t_{s}^{+} = 1 - t_{aj}^{+} = \frac{1}{3-2\beta}. \tag{8}$$

The price of commercials is

$$p_{i}^{+} = p_{s}^{+} = a \cdot (t_{aj}^{+})^{-\beta} = a\left(1 - \frac{1}{3-2\beta}\right)^{-\beta}. \tag{9}$$

As a result, $\tilde{\lambda}^{+} = 1/2$, and both channels reach the same market share of $v_{i}^{+} = v_{s}^{+} = 1/2$. Equilibrium profits are

$$\Pi_{i}^{+} = \Pi_{s}^{+} = v_{j}^{+} \cdot p_{j}^{+} \cdot t_{aj}^{+} - c_{pr} = a(2-2\beta)^{-\beta}(3-2\beta)^{-1+\beta}(1-\beta) - c_{pr}. \tag{10}$$

In this market, consumers earn a surplus of

$$CR^{+} = \int_{0}^{\tilde{\lambda}^{+}} t_{i}^{+} \cdot (1-\lambda)\, d\lambda + \int_{\tilde{\lambda}^{+}}^{1} t_{s}^{+} \cdot \lambda\, d\lambda = \frac{3}{12-8\beta}. \tag{11}$$

The first integral in equation (11) represents the consumer surplus from watching the information channel, and the second integral represents that from watching the show channel. The surplus for firms that buy commercials is

$$\begin{aligned} R^{+} &= v_{i}^{+} \int_{0}^{t_{ai}^{+}} a \cdot (t_{ai}^{+})^{-\beta} - p_{i}^{+}\, dt_{ai} + v_{s}^{+} \int_{0}^{t_{as}^{+}} a \cdot (t_{as}^{+})^{-\beta} - p_{s}^{+}\, dt_{as} \\ &= a(1-\beta)^{-\beta}\left(\frac{3}{2} - \beta\right)^{\beta-1}\beta, \end{aligned} \tag{12}$$

where the first and second terms represent the surplus for advertisers on the information channel and the show channel, respectively. Because only the viewers of the information channel, $\lambda \in [0, \tilde{\lambda}^{+}]$, consume information-type content, the social output of information consumption is

$$Y^{+} = \int_{0}^{\tilde{\lambda}^{+}} (t_{i}^{+})^{\alpha}\, d\lambda = \frac{1}{2}(3-2\beta)^{-\alpha}. \tag{13}$$

It is easy to sum up the rents and informational rents to obtain welfare, represented by

$$\begin{aligned} W^+ &= \Pi_i^+ + \Pi_s^+ + CR^+ + R^+ + Y^+ \\ &= \frac{\frac{1}{4}\left(2(3-2\beta)^{1-\alpha} + a \cdot 2^{3-\beta}\left(\frac{1}{1-\beta}+2\right)^{\beta} + 3\right) + (4\beta-6)c_{pr}}{3-2\beta}. \end{aligned} \tag{14}$$

3.2 One public service channel and two private channels

Now we consider an oligopoly with two private channels and one public service channel. Production costs c_p are financed by a non-distorting tax. The public service channel acts as a Stackelberg leader in deciding to enter the market and which type of content to broadcast. The public broadcasting of commercials may increase profits (Stühmeier and Wenzel, 2012) or remedy the market failure of the undersupply of commercials (Kind et al., 2007). However, because we investigate the market failure of the under-consumption of news, we assume that public channels do not broadcast commercials, but only information-type content t_p and show-type content $1-t_p$, as it is the case for the BBC and the Scandinavian PSB.

The governance mechanisms of public broadcasters, such as self-regulation, as in the Board of Governors of the BBC, independent regulation by an institution, or ministerial/executive regulation and Parliamentary control, influence trust in television (Conolly and Hargreaves Heap, 2007) and news consumption (Benesch, 2010). Therefore, we implicitly assume that the PSB in our model is not controlled by parties, politicians or businesses but broadcasts information-type content that can be trusted.

The public service channel broadcasting entertainment and information-type content attracts viewers from both private channels and therefore competes with both of them. However, the private channels no longer compete directly with each other. If all channels attract viewers, then a small change in the public service channel's program may induce a viewer of the show channel to switch to the public service channel, but this viewer will never switch to the information channel. A

consumer of type

$$\tilde{\lambda}_i = \frac{t_{ai} + t_p - 1}{t_{ai} + 2(t_p - 1)} \tag{15}$$

is indifferent between the information and the public service channel and a consumer of type

$$\tilde{\lambda}_s = \frac{t_p}{2t_p - t_{as}} \tag{16}$$

is indifferent between the show and the public service channel. (Figure 1).

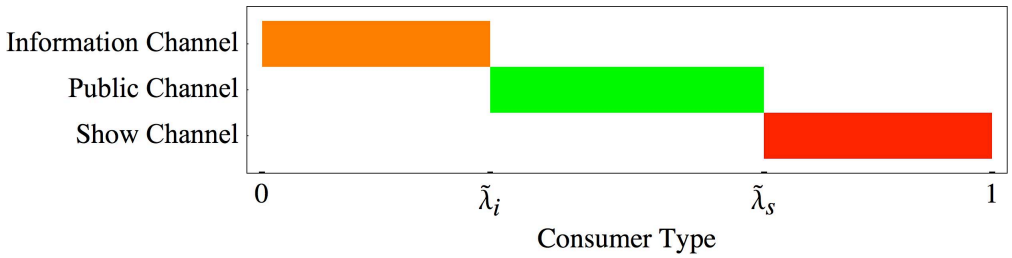

Figure 1: Consumer type and channel choice.

The private show channel therefore only competes with the public service channel. Thus, the show channel's best response to maximize profits depends only on the program policy t_p of the public service channel:

$$t^*_{as}(t_p) = \frac{\hat{\beta}}{2(1-\beta)} \cdot t_p, \tag{17}$$

with $\tilde{\beta} = \sqrt{8 - (8-\beta)\beta}$ and $\hat{\beta} = 4 - 3\beta - \tilde{\beta}$. Analogously, the best response for the private information channel is

$$t^*_{ai}(t_p) = \frac{\hat{\beta}}{2(1-\beta)} \cdot (1 - t_p). \tag{18}$$

Using these best-response functions, we derive equations for indifferent viewers and market shares. Interestingly, neither depends on the PSB program policy t_p. Indifferent viewers are represented by

$$\tilde{\lambda}^*_i = \frac{t^*_{ai} + t_p - 1}{t^*_{ai} + 2(t_p - 1)} = \frac{1}{4}\left(-\tilde{\beta} - \beta + 4\right) \tag{19}$$

and

$$\tilde{\lambda}^*_s = \frac{t_p}{2t_p - t^*_{as}} = \frac{1}{4}\left(\tilde{\beta} + \beta\right). \tag{20}$$

Thus, the public service channel attracts viewers according to

$$v_p^* = \tilde{\lambda}_s^* - \tilde{\lambda}_i^* = \frac{1}{2}\left(\tilde{\beta} + \beta - 2\right), \tag{21}$$

whereas

$$v_i^* = \tilde{\lambda}_i^* = v_s^* = (1 - \tilde{\lambda}_s^*) = \frac{1}{4}\left(4 - \tilde{\beta} - \beta\right) \tag{22}$$

viewers stay with their preferred private channel.

The prices of commercials depend on the PSB program policy t_p. The price of commercials is

$$p_i^* = a \cdot (t_{ai}^*)^{-\beta} = a \cdot 2^{\beta} \left(\frac{\hat{\beta}(1 - t_p)}{1 - \beta}\right)^{-\beta} \tag{23}$$

on the information channel and

$$p_s^* = a \cdot (t_{as}^*)^{-\beta} = a \cdot 2^{\beta} \left(\frac{\hat{\beta} t_p}{1 - \beta}\right)^{-\beta} \tag{24}$$

on the show channel.

The profits of the private channels are therefore

$$\Pi_i^* = v_i^* \cdot p_i^* \cdot t_{ai}^* - c_{pr} = \frac{a \cdot (1 - t_p)^{1-\beta} \bar{\beta} \hat{\beta}^{1-\beta}}{2^{3-\beta}(1 - \beta)^{1-\beta}} - c_{pr} \tag{25}$$

with $\bar{\beta} = 4 - \beta - \tilde{\beta}$ and

$$\Pi_s^* = v_s^* \cdot p_s^* \cdot t_{as}^* - c_{pr} = \frac{a \cdot t_p^{1-\beta} \bar{\beta} \tilde{\beta}^{1-\beta}}{2^{3-\beta}(1 - \beta)^{1-\beta}} - c_{pr}. \tag{26}$$

Private channels are only viable if profits are non-negative. High private productions costs, a small advertising market and a PSB program policy that is similar to that of the private channel reduce profits for the private channel and may trigger its exit from the market.

Consumers who watch the private information channel earn the following rents:

$$CR_i^* = \int_0^{\tilde{\lambda}_i^*} t_i^* \cdot (1 - \lambda) d\lambda = \frac{\left(\beta\left(\beta + \tilde{\beta}\right) - 2\right)\left(2 - \beta - \tilde{\beta} - t_p\hat{\beta}\right)}{2(1 - \beta)\left(\beta - \tilde{\beta}\right)^2}. \tag{27}$$

Consumers who watch the private show channel earn the following rents:

$$\begin{aligned} CR_s^* &= \int_{\tilde{\lambda}_s^*}^{1} t_s^* \cdot \lambda \, d\lambda \\ &= \frac{2-\beta\left(\beta+\tilde{\beta}\right)}{\left(\beta-\tilde{\beta}\right)^2} - \frac{t_p\left(4-\tilde{\beta}+\beta\left(1-2\tilde{\beta}-2\beta\left(3-\beta-\tilde{\beta}\right)\right)\right)}{(1-\beta)\left(\beta-\tilde{\beta}\right)^2}. \end{aligned} \tag{28}$$

Consumers who watch the public service channel earn the following rents:

$$CR_p^* = \int_{\tilde{\lambda}_i^*}^{\tilde{\lambda}_s^*} t_p \cdot (1-\lambda) + (1-t_p) \cdot \lambda \, d\lambda = -\frac{1}{2} + \frac{\beta}{4} + \frac{1}{4}\tilde{\beta}. \tag{29}$$

Firms who buy commercials from the private information channel earn the following rents:

$$R_i^* = v_i^* \int_0^{t_{ai}^*} a \cdot (t_{ai}^*)^{-\beta} - p_i^* \, dt_{ai} = \frac{a\beta\bar{\beta}(1-t_p)^{1-\beta}\hat{\beta}^{1-\beta}}{2^{3-\beta}(1-\beta)^{2-\beta}}. \tag{30}$$

Firms who buy commercials from the private show channel earn the following rents:

$$R_s^* = v_s^* \int_0^{t_{as}^*} a \cdot (t_{as}^*)^{-\beta} - p_s^* \, dt_{as} = \frac{a\beta\bar{\beta}t_p^{1-\beta}\hat{\beta}^{1-\beta}}{2^{3-\beta}(1-\beta)^{2-\beta}}. \tag{31}$$

Finally, the output of information consumption by a viewer is

$$Y^* = \int_0^{\tilde{\lambda}_i^*} (t_i^*)^{\alpha} \, d\lambda + \int_{\tilde{\lambda}_i^*}^{\tilde{\lambda}_s^*} t_p^{\alpha} \, d\lambda = \frac{t_p^{\alpha}\hat{\beta} - \left(2-\beta-\tilde{\beta}\right)\left(1-\frac{(1-t_p)\hat{\beta})}{2(1-\beta)}\right)^{\alpha}}{-\beta+\tilde{\beta}}. \tag{32}$$

It is easy to sum the above terms to obtain total welfare

$$W^* = \Pi_i^* + \Pi_s^* + CR_i^* + CR_s^* + CR_p^* + R_i^* + R_s^* + Y^* - c_p, \tag{33}$$

which depends on $(t_p, a, \alpha, \beta, c_{pr}, c_p)$.

4 PSB program policy and welfare characteristics

First we investigate the characteristics of a welfare-maximizing PSB program policy.[3]

[3]See Rothbauer and Sieg (2013), Stühmeier and Wenzel (2012), Kind et al. (2007) and Prat and Strömberg (2005) for various assumptions about the objective of the public service broad-

Proposition 1 *A welfare-maximizing PSB entering an oligopoly of two differentiated private free-to-air TV channels broadcasts both information-type and show-type content. Furthermore, an increasing α increases the welfare-maximizing broadcasting time of information-type content.*

Proof: See Appendix A.

Consider a PSB that increases its broadcasting time of information-type content. In the equilibrium, private channels react by changing the amount of commercials such that the viewer base of the channels remain unchanged (see equations 21 and 22). Therefore, increasing the information-type content increases the social output of information Y and an information-type content only PSB maximizes the social output of information. From a welfare perspective, however, it is not optimal to broadcast only information-type content. Because the information-channel has to reduce commercial broadcasting time to stabilize its viewer share (see equation 18), rents from commercials as well as revenues of the private information channel shrink. This means, that an information only PSB not only crowds out the private information channel completely but also destroys more rents from commercials than the additional information consumption improves welfare. Therefore, the welfare maximizing broadcasting time of informational content is less than 1. An information only PSB is not optimal from a welfare perspective.[4]

However, welfare maximization may not be the only objective of the PSB. The existence of the information channel is jeopardized by the PSB's broadcasting of information-type programs; likewise, the existence of the the show channels is jeopardized by the PSB's broadcasting of show-type content. Thus, the program policy authority of the PSB may want to ensure the viability of private channels. They may also fear decreasing Y and could try to ensure that Y is not sacrificed for an improvement in welfare.

caster.

[4]This may not hold for viewer groups that are not served by private free-to-air channels because there are no commercials targeted at them or for children programs if the society thinks that small children should not watch commercials because small children are not able to distinguish commercials and content.

Proposition 2 *For given* $(a, \alpha, \beta, c_{pr}, c_p)$*, market entry by a public service channel broadcasting* t_p *information-type content and* $1 - t_p$ *show-type content does not crowd out the private information channel if*

$$\Pi_i^* = \frac{a(1-t_p)^{1-\beta}\bar{\beta}\hat{\beta}^{1-\beta}}{2^{3-\beta}(1-\beta)^{1-\beta}} - c_{pr} > 0, \tag{34}$$

does not crowd out the private show channel if

$$\Pi_s^* = \frac{a \cdot t_p^{1-\beta}\bar{\beta}\tilde{\beta}^{1-\beta}}{2^{3-\beta}(1-\beta)^{1-\beta}} - c_{pr} > 0, \tag{35}$$

is welfare-enhancing if [(48) in Appendix B]

$$W^* > W^+, \tag{36}$$

and improves the social output of information consumption if [(49) in Appendix B]

$$Y^* > Y^+. \tag{37}$$

From Proposition 2, a policy-maker who knows the parameters $(a, \alpha, \beta, c_{pr})$ can check whether a PSB is welfare- or Y-enhancing and whether the PSB will push a private channel out of the market. Figure 2 is a graphical representation of the parameter combinations for welfare-improving public service channels when both private channels are viable and the social output of information consumption is enhanced.

We can also analytically prove that there is a combination of parameters $(a, \alpha, \beta, c_{pr}, c_p)$ and t_p that improves welfare, improves Y and does not push private channels out of the market by analyzing a symmetric case of market shares and profits. Both private channels and the PSB attract an equilibrium viewer market share of $1/3$ whenever $\beta = 1/3$. Both private channels earn the same profits when the public service channel broadcasts show-type content during half of its broadcasting time and information-type content during the other half; that is, $t_p = 1/2$.

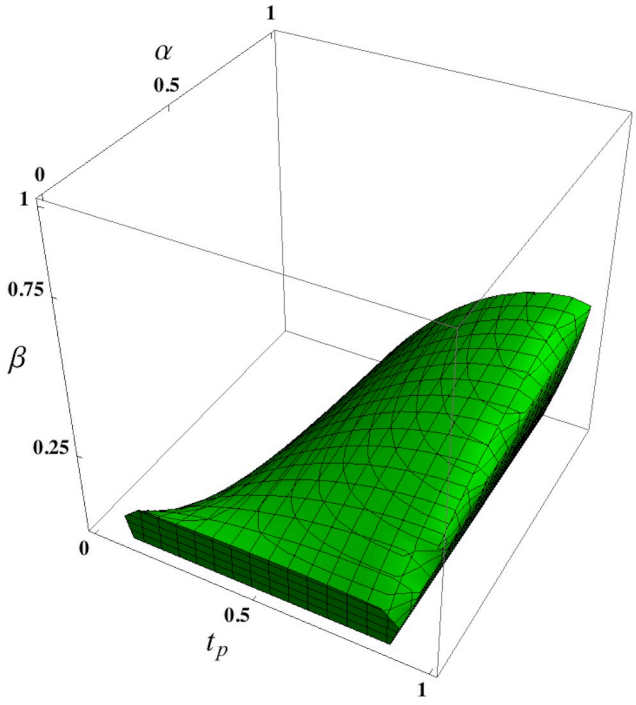

Figure 2: Welfare- and Y-enhancing parameter combinations for which both private channels are viable, $c_p = c_{pr} = 0.1, a = 0.5$.

Proposition 3 *Let* $\beta = 1/3$ *and*

$$c_p < \frac{2}{21} - \frac{1}{2}\left(\frac{3}{7}\right)^{\alpha} + \frac{2^{-\alpha}}{3} + 2^{-2\alpha}3^{-1+\alpha} = \tilde{c}. \tag{38}$$

Then, for all

$$a < \frac{-8 - 7 \cdot 2^{2-\alpha} - 7 \cdot 2^{2-2\alpha}3^{\alpha} + 2 \cdot 3^{1+\alpha}7^{1-\alpha} + 84c_p}{21 \cdot 2^{2/3} - 36 \cdot 14^{1/3}} = \tilde{a} \tag{39}$$

and

$$c_{pr} < \frac{4 + 7 \cdot 2^{1-\alpha} + 7 \cdot 2^{1-2\alpha}3^{\alpha} - 3^{1+\alpha}7^{1-\alpha} - 42c_p}{9 \cdot 2^{2/3}\left(-7 \cdot 2^{1/3} + 12 \cdot 7^{1/3}\right)} = \tilde{c}_{pr}, \tag{40}$$

a public service channel broadcasting $t_p = 1/2$ *improves both welfare and the social output of information consumption without crowding out a private channel.*

Proof: See Appendix C.

Proposition 3 shows that market entry by a public service channel improves welfare only if the PSB costs c_p are low. The value of critical PSB costs $\tilde{c}$ depends on the rate at which the marginal productivity of information consumption α diminishes. This is because the value of α determines the effect of the introduction of public service broadcasting on the social output of information consumption Y, which in turn determines the effect on welfare W.

Furthermore, the value of television advertising a must be low. The intuition behind this result is that the public channel attracts viewers who would watch private channels in the absence of public service broadcasting. In an attempt to avoid losing too many viewers, private channels decrease their commercial broadcasting times as a reaction to the market entry of a PSB. Although this reaction increases consumer surplus from watching TV, it decreases profits and advertiser surplus. In contrast to consumer surplus, profits and advertiser surplus depend on the value of television advertising. Therefore, a high value for television advertising decreases the likelihood that public service broadcasting will improve welfare.

The critical value for television advertising $\tilde{a}$ depends on α and on PSB costs. If these costs are high, then the surplus lost by advertisers and the profits lost by private channels have to be low to ensure that public service broadcasting is welfare-enhancing.

The third inequality ensures not only that PSB market entry is welfare-enhancing, but also that private channels are still profitable. To obtain this result, private channel costs c_{pr} must be low. The critical costs for private channels $\tilde{c}_{pr}$ also depend on α and PSB costs. If it is assumed that PSB costs increase, then to still trigger an increase in welfare through PSB market entry, advertising must have a low value. However, a low value of advertising triggers low profits, such that private costs have to be low to ensure that private channels are still profitable. Thus, for high PSB costs, private costs must be low to ensure that welfare increases and channels are profitable when a public service channel enters the market.

There is no restriction on the change in the social output of information consumption Y because, in the symmetric case $\beta = 1/3$, and $t_p = 1/2$ and the increase

in social output of information is

$$Y^* - Y^+ = \frac{2^{1+\alpha} + 3^\alpha \left(2 - 3\left(4/7\right)^\alpha\right)}{3 \cdot 2^{1+2\alpha}} > 0 \tag{41}$$

for all $0 < \alpha \leq 1$.

5 Conclusion

The digitalization of the media sector has significantly decreased barriers to entry in the broadcasting industry. Market failures based on these barriers thus tend to be less important. As a result, the question of whether market intervention through public service broadcasting is justified has to be re-examined. A market failure that continues in a digital world is that the individual consumption of information does not take its external benefits to society into account, such that aggregated information consumption is expected to be less than socially optimal. To remedy this information externality, a public service channel may enter the market. Because this event affects not only the information consumption of voters but also the market shares of private channels and rents of advertisers, we evaluated the overall welfare effect of the market entry or exit of a Public Service Broadcaster.

We analyzed a differentiated duopoly in a free-to-air TV market in the absence of a PSB and in the presence of a PSB that broadcasts both informational and entertainment content. Whether a PSB increases welfare depends on its costs and the importance of the advertising industry. If the PSB has high costs or if the advertising industry generates large rents for society, there is a only small probability that welfare will be improved by public service broadcasting.

Our argument only applies to an ideal PSB. It should not be abused to justify some actually occurring phenomena such as the focus on viewing rates, multi-channel PSBs or the purchase of expensive broadcasting rights of the most popular sports events. Because of their high associated costs expensive sport rights and multi-channel PSBs are not justified by our argument. However, a well-designed PSB broadcasting information-type and show-type content may remedy the market failure of rational ignorance. It can improve the information consumption of viewers and thereby improve the ability of voters to control politicians.

Appendix A: Proof of Proposition 1

$$\frac{\partial \Delta W}{\partial t_p} = -\frac{2^\beta a \hat{\beta}\left(\left(\frac{(1-t_p)\hat{\beta}}{1-\beta}\right)^{-\beta} - \left(\frac{t_p \hat{\beta}}{1-\beta}\right)^{-\beta}\right)\bar{\beta}}{8(1-\beta)} + \frac{\alpha\hat{\beta}\left(2{t_p}^{-1+\alpha} + \frac{\left(1-\frac{(1-t_p)\hat{\beta}}{2(1-\beta)}\right)^{-1+\alpha}\left(-2+\beta+\tilde{\beta}\right)}{1-\beta}\right)}{2(-\beta+\tilde{\beta})} \tag{42}$$

Because $\lim_{t_p \to 0, t_p > 0} \partial \Delta W / \partial t_p = \infty$ and $\lim_{t_p \to 1, t_p < 1} \partial \Delta W / \partial t_p = -\infty$, neither $t_p = 0$ nor $t_p = 1$ is optimal. Furthermore, because $0 < \beta < 1$, it holds that $\bar{\beta} > 0$, $\hat{\beta} > 0$, and

$$\left(\frac{(1-t_p)\hat{\beta}}{1-\beta}\right)^{-\beta} - \left(\frac{t_p \hat{\beta}}{1-\beta}\right)^{-\beta} \leq 0 \tag{43}$$

if $0 < t_p \leq 1/2$. Therefore, the first term of equation 42 is, considering the negative sign, positive if $0 < t_p \leq 1/2$. The second term of equation 42 is, because $-2 + \beta + \tilde{\beta} > 0$ and $-\beta + \tilde{\beta} > 0$ if $0 < \beta < 1$, always positive. To summarize, $\partial \Delta W / \partial t_p > 0$ for $0 \leq t_p \leq 1/2$ and no $0 \leq t_p \leq 1/2$ is optimal.

We denote the welfare-maximizing fraction of PSBs information-type program with t_p^* and define $\Psi(t_p^*, \alpha) = \partial \Delta W / \partial t_p = 0$. Then

$$\begin{aligned} \frac{dt_p^*}{d\alpha} &= -\frac{\partial \Psi / \partial \alpha}{\partial \Psi / \partial t_p} \\ &= \frac{\left(\frac{1+\alpha \log[t_p]}{t_p^{1-\alpha}} - \frac{(1+\alpha\log[\phi])\phi^\alpha\left(-2+\beta+\tilde{\beta}\right)}{-2+2\beta+\hat{\beta}-t_p\hat{\beta}}\right)}{\frac{a\beta 2^\beta\left(\frac{\left(\frac{t_p\hat{\beta}}{1-\beta}\right)^{-\beta}}{t_p} + \frac{\left(\frac{(1-t_p)\hat{\beta}}{1-\beta}\right)^{-\beta}}{1-t_p}\right)\left(-\beta+\tilde{\beta}\right)\bar{\beta}}{8(1-\beta)} + (1-\alpha)\alpha\left(\frac{1}{{t_p}^{2-\alpha}} - \frac{\hat{\beta}\left(2-\beta-\tilde{\beta}\right)}{4(1-\beta)^2\phi^{2-\alpha}}\right)} \end{aligned} \tag{44}$$

with

$$\phi = 1 - \frac{(1-t_p)\hat{\beta}}{2(1-\beta)} \tag{45}$$

Because $0 < \beta < 1$, it holds that $2-\beta-\tilde{\beta} < 0$, $\bar{\beta} > 0$, $\hat{\beta} > 0$ and $\phi > 0$. Therefore

$$-\frac{\hat{\beta}\left(2-\beta-\tilde{\beta}\right)}{4(1-\beta)^2\phi^{2-\alpha}} > 0 \tag{46}$$

and the denominator of (44) is positive. Because $-2+2\beta+\hat{\beta}<0$ and $\hat{\beta}>0$, $-2+2\beta+\hat{\beta}-t_p\hat{\beta}<0$. Using $-2+\beta+\tilde{\beta}>0$,

$$-\frac{(1+\alpha\log[\phi])\,\phi^{\alpha}\left(-2+\beta+\tilde{\beta}\right)}{-2+2\beta+\hat{\beta}-t_p\hat{\beta}}>0 \tag{47}$$

and the numerator of (44) is positive. It follows that $dt_p^*/d\alpha>0$, as stated in the proposition.

Appendix B: Proof of Proposition 2

$$\begin{aligned}
&\Delta W=W^*-W^+>0\iff\\
&2^{\beta}a\left((1-t_p)^{\beta}t_p+(1-t_p)t_p^{\beta}\right)\bar{\beta}\hat{\beta}\left(\frac{(1-t_p)t_p\hat{\beta}}{1-\beta}\right)^{-\beta}\\
&-\frac{4(1-\beta)}{(\beta-\tilde{\beta})^2}[2\beta-\beta^3+2t_p(4+\beta(1-2(3-\beta)\beta))-2\tilde{\beta}\\
&+2(1-\beta)\left(1-\frac{(1-t_p)\hat{\beta}}{2(1-\beta)}\right)^{\alpha}\left(\beta-\tilde{\beta}\right)\left(-2+\beta+\tilde{\beta}\right)\\
&+\tilde{\beta}\left(2t_p(-1-2(1-\beta)\beta)+\beta\tilde{\beta}\right)+\hat{\beta}\left(2t_p^{\alpha}(1-\beta)\left(\beta-\tilde{\beta}\right)+t_p\left(-2+\beta^2+\beta\tilde{\beta}\right)\right)]\\
&>\left(8c_p+\frac{2\left(3+2(3-2\beta)^{1-\alpha}+8a\left(1+\frac{1}{-3+2\beta}\right)^{-\beta}\right)}{3-2\beta}\right)(1-\beta)^2
\end{aligned} \tag{48}$$

$$\Delta Y=Y^*-Y^+>0\iff\frac{\left(\tilde{\beta}+\beta-2\right)\left(1-\frac{\hat{\beta}(t_p-1)}{2(\beta-1)}\right)^{\alpha}+\hat{\beta}{t_p}^{\alpha}}{\tilde{\beta}-\beta}>\frac{1}{2}(3-2\beta)^{-\alpha} \tag{49}$$

Appendix C: Proof of Proposition 3

If $\beta=1/3$ and $t_p=1/2$, then the difference W^*-W^+ is positive if and only if

$$a<\frac{-8-7\cdot 2^{2-\alpha}-7\cdot 2^{2-2\alpha}3^{\alpha}+2\cdot 3^{1+\alpha}7^{1-\alpha}+84c_p}{21\cdot 2^{2/3}-36\cdot 14^{1/3}}=\tilde{a} \tag{50}$$

and $\tilde{a} > 0$ if and only if

$$c_p < \frac{2}{21} - \frac{1}{2}\left(\frac{3}{7}\right)^{\alpha} + \frac{2^{-\alpha}}{3} + 2^{-2\alpha}3^{-1+\alpha} = \tilde{c}. \tag{51}$$

If the public service channel chooses $1/2 = t_p$, then $\Pi_i = \Pi_s$ and $\Pi_i = \Pi_s \geq 0$ have to hold for two viable channels.

$\Pi_i = \Pi_s \geq 0$ iff

$$c_{pr} \leq \tilde{a}/(6 \cdot 2^{1/3}) = \frac{4 + 7 \cdot 2^{1-\alpha} + 7 \cdot 2^{1-2\alpha}3^{\alpha} - 3^{1+\alpha}7^{1-\alpha} - 42c_p}{9 \cdot 2^{2/3}\left(-7 \cdot 2^{1/3} + 12 \cdot 7^{1/3}\right)} = \tilde{c}_{pr}.\square \tag{52}$$

References

Anderson, Simon P. and Coate, Stephen (2005). Market provision of broadcasting: A welfare analysis. *Review of Economic Studies*, 72, 947–972.

Armstrong, Mark (2005). Public service broadcasting. *Fiscal Studies*, 26(3), 281–299.

Armstrong, Mark and Weeds, Helen (2007). Public servic broadcasting in the digital world. In Paul Seabright and Jürgen von Hagen (Eds.), *The Economic Regulation of Broadcasting Markets - Evolving Technology and Challenges for Policy* (pp. 81–149). Cambridge University Press.

Benesch, Christine (2010). *Governance of Public Broadcasters and Television Consumption*. Working Paper 2010 - 18, CREMA.

Choi, Jay Pil (2006). Broadcast competition and advertising with free entry: Subscription vs. free-to-air. *Information Economics and Policy*, 18, 181–196.

Commission (2009). Communication from the commission on the application of state aid rules to public service communication from the commission on the application of state aid rules to public service broadcasting. *Official Journal of the European Union*, C 257.

Conolly, Sara and Hargreaves Heap, Shaun P. (2007). Cross country differences in trust in television and the governance of public broadcasters. *Kyklos*, 60(1), 3–14.

Debrett, Mary (2009). Riding the wave: public service television in the multiplatform era. *Media, Culture & Society*, 31(5), 807–827.

Downs, Anthony (1957). *An Economic Theory of Democracy*. Harper & Row.

Franklin, Bob (2001). *British Television Policy: A Reader*. London: Routledge.

Gabszewicz, Jean J., and Laussel, Didier, and Sonnac, Nathalie (2004). Programming and advertising competition in the broadcasting industry. *Journal of Economics and Management Strategy*, 13(4), 657–669.

Grossman, Gene M. and Shapiro, Carl (1984). Informative advertising with differentiated products. *The Review of Economic Studies*, 51(1), 63–81.

Hargreaves Heap, Shaun P. (2005). Television in a digital age: what role for public service broadcasting? *Economic Policy*, 20(41), 111+113–157.

Kind, Hans Jarle, and Nilssen, Tore, and Sørgard, Lars (2007). Competition for viewers and advertisers in a TV oligopoly. *Journal of Media Economics*, 20(3), 211–233.

Oreja, Marcelino (1998). *The Digital Age European Audivisual Policy*. The European Commssion.

Peitz, Martin and Valletti, Tommaso M. (2008). Content and advertising in the media: Pay-TV versus free-to-air. *International Journal of Industrial Organization*, 26, 949–965.

Prat, Andrea and Strömberg, David (2005). Commercial television and voter information. *CEPR Discussion Paper*, 4989.

Prat, Andrea and Strömberg, David (2011). The political economy of mass media. *CEPR Discussion Paper*, DP8246.

Rothbauer, Julia and Sieg, Gernot (2013). Public service broadcasting of sport, shows, and news to mitigate rational ignorance. *Journal of Media Economics*, 26, 21–40.

Stühmeier, Torben and Wenzel, Tobias (2012). Regulating advertising in the presence of public service broadcasting. *Review of Network Economics*, 11(2), Article 1.

von Hagen, Jürgen and Seabright, Paul (2007). Introduction: The future of economic regulation in broadcasting markets. In Paul Seabright and Jürgen von Hagen (Eds.), *The Economic Regulation of Broadcasting Markets - Evolving Technology and Challenges for Policy* (pp. 3–10). Cambridge University Press.