Economic Distortions Caused by Public Funding of Broadcasting in Europe

by Ingo Kohlschein

Munich Graduate School of Economics
Department of Economics
LMU Munich, Germany

Email: ingo.kohlschein@lrz.uni-muenchen.de
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Abstract: In the European broadcasting markets commercial television stations compete with broadcasters that receive public funds. In this paper, a duopoly model of broadcasting is applied to show the welfare implications of state funding of broadcasting to viewers and advertisers. Viewers benefit from decreasing levels of advertising in the programs but dislike the mandatory payment of license fees. In contrast, advertisers face increasing prices for commercials and on this account part of their rent dwindles away. The overall effect on the rents is ambiguous and it is not clear-cut that public service broadcasting improves welfare compared to a situation of pure commercial broadcasting.* (102 words)

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1 Introduction

In most members states of the European Union commercial television broadcasters and public service broadcasters (PSB) coexist.\(^1\) The commercial stations derive their income basically from advertising. In contrast, most PSB in the EU are financed by a mix of advertising income and public funds.\(^2\) Nevertheless, the commercial stations and the PSB compete in the same viewer and advertising markets. For a long time, commercial broadcasters in the EU have claimed that publicly funded broadcasters who collect advertising in addition to state aid distort markets in excess of what is acceptable to the public interest.\(^3\)

Until now, contributions from economics have not determined the consequences caused by the coexistence of the two types of broadcasters and how to ensure fair competition in the markets. In addition, it is unclear how the state funding of broadcasting affects the welfare of viewers and advertisers. In this paper a duopoly model is presented in which a commercial broadcaster competes with a public service broadcaster that receives state funds in addition to its advertising revenue. The public service broadcaster then attracts viewers from its commercial rival by lowering the level of advertising in its program. I will show the welfare implications to viewers and advertisers and will determine under what circumstances state funding of broadcasting improves welfare.

Nowadays, the economics of television are embedded into the theory of two-sided markets and inter-market network effects. Recently, the theory of two-sided markets has considerably been shaped by contributions by Rochet and Tirole (2002) and Armstrong (2004). The theory considers economic questions in which an intermediary serves two inter-linked markets of consumers simultaneously, e.g., a credit card firm that deals with cardholders on the one hand and shop owners on the other.

Media markets represent an appealing application of the theory of two-sided markets. The trade-off between the audience and the advertising markets has been described intelligibly by

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\(^1\)The analysis relates to the situation before the accession of ten new member states to the EU on May 1st, 2004. However, the basic insights from the model can be applied to the new members states as well.

\(^2\)This scheme of financing is most common in the EU and is denoted as "mix-funding." In contrast, some PSB in the EU are purely fee financed as the BBC in Great Britain or TVDenmark in Denmark. Furthermore, the British PSB Channel4 is financed by commercial income only.

Vaglio (1995): Broadcasters can either reduce the advertising in their program and attract a larger audience or they can stuff their program with advertising interruptions and lose audience.

In recent studies a canonical setup has emerged to model television broadcasting markets. For my own work the studies by Anderson and Coate (2004), Gabszewicz, Laussel and Sonnac (2004), and Gal-Or and Dukes (2002) are most relevant. These papers share a number of theoretical underpinnings: Advertising is modelled as nuisance to viewers; broadcasters compete over Hotelling style viewer preferences; broadcasters sell the advertising spots in their programs as monopolists; competition takes place in a duopoly setting between two symmetric commercial broadcasters; variable costs are assumed to be zero.

Anderson and Coate are mainly concerned with the optimal provision of advertising and the nature of market failure in the industry. They find that advertising can either be undersupplied or oversupplied and that there is no clear-cut rule for regulating advertising levels. Gabszewicz, Laussel and Sonnac find that advertising ceilings reduce program differentiation. In contrast to Anderson and Coate, they allow viewers to opt for a personal mix out of the two stations and they introduce an explicit advertising demand function. Gal-Or and Dukes also allow viewers to make up a personal mix from the two stations. In addition, they endogenize the location choice of the broadcasters on the Hotelling interval. They assess the incentives of commercial media firms to reduce program differentiation and incentives for media mergers. A common feature of these models is that the viewing demand depends on the advertising levels in the programs but not on the programs’ quality. An alternative setup is provided by Nilsson and Sorgard (2001). In their model TV channels can invest in their programs to attract additional viewers.

In this paper, the canonical duopoly setup is extended to the case of public service broadcasting. In my model one of the two stations receives state funds in addition to its advertising revenue. The amount of the public transfers depends on the level of the license fee that is levied on all viewers and on the success of the station in the viewer market. Under such circumstances the symmetric equilibrium from the canonical setup is substituted by an asymmetric one in which the PSB attracts viewers from its commercial rival by lowering the level of advertising in its program. The preceding welfare analysis is inspired by the work of Anderson and Coate. It will be shown that the benefits of viewers may increase or decrease when one station receives public funds. The direction of the change depends on the relation of the level of the license fee to the
nuisance cost of advertising and the substitutability of the channels. The rent of the advertising
firms is strictly reduced due to the cut in the number of advertising spots that is sold by the TV
channels. Frictions from the license fee mechanism lead to an additional reduction of welfare.

The paper proceeds as follows: Section 2 presents an overview of empirical findings from the
television markets in the European Union. The canonical setup based on Anderson and Coate is
summed up in section 3. In section 4, the new model of public service broadcasting is introduced
and the asymmetric equilibrium is derived. The welfare implications of the equilibrium are
analyzed in section 5. In section 6, extensions and applications of the model are developed. The
conclusion in section 7 provides policy recommendations with respect to the situation of the
television markets in the European Union.

2 The European TV Broadcasting Markets

In the EU public service broadcasting still plays an important role. In 2002, these stations
counted on average for a daily audience market share of 41\%\footnote{This number represents an
unweighted average across all EU member states not controlling for each country’s
audience size.}. The market share was lowest in Greece with 11\% and highest in Denmark with 70\%.
In the large member states Germany, France, Great Britain, and Italy, the average market lay between 45\% and 48\%\footnote{see: Yearbook of the European Audiovisual Observatory 2003, Vol. 2, table 8.2, p. 60.}

The terms of financing of public service broadcasting in the EU are highly heterogenous.
License fees\footnote{License fees are here understood as a regular charge levied by the government or a public authority on viewers or households for the ownership of a TV set.} are not paid by viewers in Greece, Luxembourg, Spain, Portugal, the Netherlands, and the Flemish part of Belgium. In the four latter countries public service television is financed
by direct transfers from the general budget\footnote{see: The Financial Situation of Public Radio-Television Companies in Europe is Deteriorating. Press release by the European Audiovisual Observatory, April 9, 2002.}. In Greece, there is a mark-up on electricity. In
all other member states some form of license fee transfers exists for television. But the annual
level of the fees varies significantly: In the year 2000, average annual license fees per capita were
highest in Denmark (79 \(\text{€}\)), Germany (74 \(\text{€}\)), and Sweden (71 \(\text{€}\)). In contrast, average fees were
low in Ireland (22 \(\text{€}\)), Italy (23 \(\text{€}\)) and Belgium (35 \(\text{€}\))\footnote{These figures were calculated including both TV and radio broadcasting.}. Overall, the share of commercial income
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in the PSB budget rose from 28\% in 1995 to 32\% in 2000. During the same period the share
of public funds decreased from 69% to 66%. Accordingly, PSB in Europe became increasingly financed by advertising income.

The rules on advertising for public service broadcasters differ significantly in the EU member states. In Great Britain, the BBC must not broadcast any advertising. In Germany, ARD and ZDF are allowed to show advertising but less than their commercial rivals. In Denmark, one of the two public service broadcasters, TV2, is allowed to deliver the same amount of advertising as its commercial competitor TVDanmark2.

The differences in the financing schemes of public service broadcasting and in the advertising rules lead to a highly heterogeneous environment of broadcasting in Europe. Commercial stations face a different competitive structure in each EU member state. However, the regulatory role of the EU Commission is limited. An amendment to the EC Treaty, the so called "Amsterdam Protocol", assigns discretion over the terms of financing of public service broadcasting to the member states. The Commission’s department for Competition only is concerned about fundamental errors in the definition and entrustment of public service broadcasting as a service of general economic interest. In addition, the Commission controls whether a PSB has been over-compensated for its extra cost from the public service obligations and if trade among member states has been affected thereby.

In line with its communication on the application of state aid rules to public service broadcasting\textsuperscript{9}, the Commission carried out state aid decisions on RAI in Italy, on France 2 and 3, and on RTP in Portugal. In a case of the year 2004, the Commission ordered the mix-funded Danish public service broadcaster TV2 to reimburse 84.4 million Euros of overcompensation to the Danish state. The Commission found that this amount of public financing was not proportionate to the net cost of providing the public service and ruled it as illegal state aid.\textsuperscript{10}

\section{3 Canonical Setup}

In this chapter a canonical setup of television markets is introduced that has recently emerged within the theory of two-sided markets. This presentation of the setup builds on a symmetric

\textsuperscript{9}see: \textit{Communication on the Application of State Aid Rules to Public Service Broadcasting.} European Commission Official Journal C320, November 15, 2001, 5-11.

\textsuperscript{10}see: \textit{Commission Orders Danish Public Broadcaster TV2 to Pay Back Compensation for Public Service Task.} Press release by the EU Commission, May 19, 2004, IP/04/666.
duopoly model of commercial broadcasters used by Anderson and Coate (2004) and Armstrong (2004). Based on this setup, a new model is developed in the next chapter that deals with the case of public funded broadcasting.

In the model of Anderson and Coate two symmetric commercial stations compete for viewers and advertisers. Both broadcasters are commercial firms and entirely financed by advertising revenues. The viewing demand is modeled by using a classical Hotelling setup of spatial competition. Accordingly, there is a continuum of viewers who are assumed to be distributed uniformly over a line segment of length one. The two broadcasters, indexed by \( i, i = A, B \), are located at the ends of the interval, i.e. at the "addresses" zero and one. The model abstracts from an endogenous choice of the locations and from market entry by new broadcasters.

3.1 Viewing Demand

There is a population of mass \( N \) that likes watching television. A viewer’s position on the unit interval is indexed by \( \lambda \in [0,1] \), the distance from the left end of the segment. Viewers have unit demand, facing a discrete choice between either watching channel \( A \) or \( B \). TV consumption provides a gross utility of \( \beta \). Viewers choose the station in a one-period context (e.g. one hour), so that each viewer consumes only one channel.

The channels can carry advertising, measured by the number of producers that decide to advertise on channel \( i \), \( a_i \). The advertising causes a disutility to viewers measured by \( \gamma a_i \). Thus, TV viewers are assumed to feel annoyed by advertising.\(^{11}\) In addition, viewers face disutility from not watching their perfectly preferred program. This effect resembles the well-known transportation costs in the classic Hotelling setup. The cost of this program mismatch is \( \tau \). The parameter describes the substitutability in consumption between the two stations, \( A \) and \( B \).

In the absence of license fee payments, a viewer of type \( \lambda \) gains utility from watching channel

\(^{11}\)Mittal (1994) reported from a survey that 48% (of 300 interviewees from a consumer panel) either strongly or somewhat disliked TV advertising overall. Only 23% liked it either somewhat or strongly. 61% of the interviewees said that newspaper advertising is less annoying than TV advertising. (For a more general treatment of how advertising works see Vakratsas and Ambler (1999). In a more recent survey in Germany, 83.1% of the respondents said that there is too much advertising in television. In contrast, 27.1% replied that there is too much advertising in radio and only 19.5% think so about newspapers (see: TV-Spots nerven am meisten. In: Horizont 27, 2004). A logic argument why TV advertising bothers viewers is the following: Free-to-air television is provided to viewers without a direct charge. Viewers may face some fixed costs for installing a TV set but the reception itself is for free. The viewers "pay" by their attention to advertising. No money is exchanged, but eyeballs are. It seems that TV broadcasting in particular subsidizes viewers with content for watching advertising. If viewers would like advertising, then TV station could charge them for attending broadcasting stuffed by advertising.
A of \( u_A (\lambda, a_A) = \beta - \gamma a_A - \tau \lambda \) and from watching channel \( B \) of \( u_B (\lambda, a_B) = \beta - \gamma a_B - \tau (1 - \lambda) \). The point at which a type-\( \lambda \) viewer is indifferent between the two channels, \( \lambda^* \), is the point where

\[
\lambda^* = \frac{1}{2} + \frac{\gamma (a_B - a_A)}{2 \tau}
\]

To induce the type-\( \lambda \) viewer in the symmetric equilibrium to watch TV at all, the condition \( \beta - \frac{\tau}{2} \geq \gamma a \) must hold. For an interior solution of \( \lambda^* \) the advertising level \( a_A \) has to fall within the interval \( a_A \in \left[ a_B - \frac{\tau}{\gamma}, a_B + \frac{\tau}{\gamma} \right] \).

The viewing demand functions of the broadcasters are

\[
V_A (a_A, a_B) = N \left[ \frac{1}{2} + \frac{\gamma (a_B - a_A)}{2 \tau} \right] \quad \text{and} \quad V_B (a_A, a_B) = N \left[ \frac{1}{2} - \frac{\gamma (a_B - a_A)}{2 \tau} \right]
\]

where \( V_i \) denotes a station’s audience market share.

These viewing demand functions are linear in \( a_i \) with \( \frac{\partial V_i}{\partial a_i} = -\frac{N \gamma}{2 \tau} < 0 \). Accordingly, the marginal change is strictly negative and independent of \( a \). In addition, there is a cross-effect with \( \frac{\partial V_i}{\partial a_j} = \frac{N \gamma}{2 \tau} \) for \( i \neq j \). Note that viewers derive no net benefits from purchasing the goods and services that are sold through advertising (the problem’s SOC and the check for uniqueness of the equilibrium are provided in the appendix 8.1).

### 3.2 Advertising Demand

Producers insert advertising into the broadcasters’ program in order to enhance sales of goods and services. Producers are ranked according to their willingness to pay for advertising per viewer. Each producer’s rank depends on an exogenous type, e.g. the net value of the good or service that the firm delivers. The quantity of advertising that a producer can buy is normalized to one.

The per-viewer inverse demand for advertising of a producer on channel \( i \) is denoted by \( p_i (a_i) \). The distribution of producers is such that this per-viewer demand function is concave and strictly decreasing in \( a_i \), i.e. \( \frac{\partial p_i (a_i)}{\partial a_i} < 0 \) and \( \frac{\partial^2 p_i (a_i)}{\partial a_i^2} \leq 0 \). Given \( a_i \), some fraction of the producers finds it profitable to place an advertisement in one or both channels. The total number of producers
is $M$.

The inverse per-viewer advertising demand function is concave because the efficiency of advertising per viewer vanishes with the quantity of advertising that is seen by this viewer. Producers dislike being one among many in a station’s advertising broadcasting. They prefer a unique positioning that generates higher attention of the viewers and promotes sales in a more valuable way. This effect should not be confused with the annoyance caused by advertising or the preference of the advertisers to reach as many viewers as possible.

According to this assumption, each viewer is of equal value to an advertiser. There are no diminishing returns since for the advertiser all viewers within a target group are equally likely to purchase a good or service. If an advertiser wants to contact viewers in the group aged 14-29, then all viewers within this target group are of equal value. Here it is assumed that the target group is the entire population, $N$.

Thus, the producers’ advertising demand depends only on the per-viewer price of advertisement, i.e. $\frac{\partial p(a_i)}{\partial V_i} = 0$. In addition, no cross-price effects occur in the model, i.e. $\frac{\partial p(a_i)}{\partial V_j} = 0$. Finally, the producers’ willingness to pay is limited by the highest type in the distribution, i.e. $p_{max}(a_i) = \overline{\sigma}$.

### 3.3 Symmetric Equilibrium

In this section, the symmetric equilibrium is presented that arises between the two identical broadcasters in the absence of any public transfers with $a_i = a_j = a$. The two broadcasters choose the advertising quantities in their programs simultaneously. The revenues from advertising increase proportionally to their viewer share. The broadcasters’ per-viewer revenue curve is $R(a) = p(a) \cdot a$. The distribution of the producers is such that $R(a)$ is concave with $R'(a) < \frac{R(a)}{a}$ and $R''(a) \leq 0$ for $a > 0$.

The two firms are symmetric and the outcome of the game is symmetric as well. Both broadcasters set identical advertising rates and share the viewer market by half (assume that all viewers watch). Thus, the game results in equal advertising levels, equal viewer shares and equal profits. The equilibrium level of $a$ is denoted by $\hat{a}$.
Each broadcaster’s objective function is

\[ \pi(a) = R(a) \cdot V(a) \]

Thus, a firm’s profit is composed of the per-viewer advertising revenue multiplied by its viewer share. Variable and fixed costs are assumed to be zero. Put differently, all costs are assumed to be sunk. This assumption is reasonable for the case of broadcasting where the first-copy-cost and the fixed costs of running a network represent the major part of a firm’s costs. The variable cost of reaching another viewer or selling another advertising slot are negligible.

Assuming that \( a > 0 \), the equilibrium is characterized by the FOC

\[ \frac{\partial \pi(a)}{\partial a} = R'(a) \cdot V(a) + R(a) \cdot V'(a) = 0 \]

\[ \Leftrightarrow R'(\tilde{a}) \cdot V(\tilde{a}) = \frac{N \gamma}{2\tau} \cdot R(\tilde{a}) \]

The broadcasters’ optimality condition features two opposite effects. The first effect, \( R'(\tilde{a}) \cdot V(\tilde{a}) \), is known from models of monopolistic competition (the stations are monopolists over selling their audience ratings to the advertisers). Accordingly, the first effect can be regarded as marginal revenue of a monopolist. This effect is weighted by the station’s viewer share. The second term, \( R(\tilde{a}) \cdot V'(\tilde{a}) = \frac{aN}{2\tau} R(\tilde{a}) \), represents the change in profits due to the change in the station’s viewer share. For example, an increase in the advertising quantity causes the station’s viewer share to fall. This term can be regarded as the marginal cost of a change in the advertising level.

Using \( V(\tilde{a}) = \frac{N}{2\tau} \) the optimality condition can be simplified to

\[ R'(\tilde{a}) = \frac{\gamma}{\tau} R(\tilde{a}) \]

Accordingly, the broadcasters choose \( a \) such that \( \frac{R'(\tilde{a})}{R(\tilde{a})} = \frac{\gamma}{\tau} \) where the LHS of this condition is strictly decreasing in \( a \) for \( a > 0 \). The broadcasters’ optimal choice of the advertising level is decreasing in the nuisance cost of advertising (\( \gamma \)) and increasing in the programs’ substitutability (\( \tau \)).
Recall that the per-viewer revenue function $R(a)$ is concave. This function has its global maximum at $R'(a) = 0$. This condition is fulfilled in the case of a monopoly with full viewing coverage. For future reference, denote the level of $a$ that maximizes $R(a)$ under such circumstances by $a^*$. Note that for all cases where externalities are present, the advertising level will be lower than $a^*$. This implies that for all such cases $R'(a) > 0$.

4 Model of Public Service Broadcasting

Assume now that the government decides to transform the station at position zero, station A, into a public service broadcaster. The government sets up a system of license fee transfers. Each viewer has to pay an amount $f$ regardless if he actually watches the PSB or not. The license fee is collected by an independent authority and then partly submitted to the PSB in dependence on its viewer share. Before a more detailed description and reasoning for this setup is provided, take notice of the modified functional form of the the viewers’ utility and the broadcasters’ objective functions.

A viewer of type $\lambda$ gains utility from watching the public service broadcaster, channel A, of

$$u_A(\lambda, a_A) = \beta - \gamma a_A - \tau \lambda - f$$

and from watching the private channel, channel B, of

$$u_B(\lambda, a_B) = \beta - \gamma a_B - \tau (1 - \lambda) - f$$

The introduction of the license fee has no direct impact on the location of the marginal viewer. As before, viewers for whom $\lambda \leq \frac{1}{2} + \frac{\gamma}{2\tau} (a_B - a_A)$ will watch channel A, and the remainder will watch channel B, i.e. $V_A(a_A, a_B) = N \left( \frac{1}{2} + \frac{\gamma}{2\tau} (a_B - a_A) \right)$ and $V_B(a_A, a_B) = N - V_A(a_A, a_B)$.

When maintaining the assumption that all people watch, the PSB’s modified objective function is

$$\pi_A(a_A, a_B) = R(a_A) \cdot V_A(a_A, a_B) + V_A(a_A, a_B) \cdot \theta f$$

The PSB’s revenue now depends on advertising income and license fees. The parameter $\theta \in [0, 1]$
captures an efficiency loss caused by collecting and transferring the license fees.

The commercial station's objective function is as before

\[ \pi_B (a_A, a_B) = R(a_B) \cdot V_B (a_A, a_B) \]

In this setup, the amount of fees that is transferred to the public service broadcaster depends directly on its viewer share. Even though this mechanism might not be observed in reality, it resembles the common way of PSB financing in many countries. When public authorities decide about the amount of fees that they transfer to a PSB, they base this decision on the station's success in reaching a large audience. A public service broadcaster with no (or a small) audience is likely to be closed down by the ruling political power. In contrast, public funding might be increased if the broadcaster generates large audiences and thereby political goodwill. This setup distinguishes the analysis from tax transfer models and pay-TV models.

Recall that the payment of the fee is mandatory for all TV viewers, regardless if they actually watch the PSB or not. However, the distribution of the fees depends on the viewer share of the PSB. Accordingly, the total amount of fees collected is \( N \cdot f \). In contrast, the share that is distributed to the PSB is \( V_A \cdot \theta f \). The rest of the total fees collected, \( Nf - V_A \cdot \theta f \), is spent by the state on other broadcasting activities that do not impact the station choice of the viewers. At a first glance, this mechanism may look artificial. But it resembles the code of praxis in many countries. In Germany, for example, some fraction of the total amount of fees is spent on administration and monitoring, on minority programs or on the development of new broadcasting technologies. My setup approximates this idea. Note also, that an amount of \( N \cdot (1 - \theta) f \) is entirely lost. This loss represents inefficiencies in the license fee transfer mechanism that I will deal with in the welfare analysis.

### 4.1 Asymmetric Equilibrium

In the following section, the effects caused by the introduction of the license fee on the broadcasting markets are analyzed in detail. As soon as \( f > 0 \), station \( A \)'s profit function exhibits two revenue components: Revenue from advertising and revenue from the license fees. Both firms are pushed away from the initial symmetric equilibrium and a new asymmetric equilibrium
materializes.

From the previous section it is clear that the PSB’s profits increase directly by \( V_A(a_A, a_B) \cdot \theta f \), when the station receives license fee transfers. However, the license fee transfers cause a series of additional effects on both firms and in both markets.

To see this, consider the PSB’s modified FOC

\[
V_A(a_A, a_B) \cdot R'(a_A) = \frac{\gamma N}{2\tau} \cdot [R(a_A) + \theta f]
\]

\[
R'(a_A^*) = \frac{\gamma}{\tau + \gamma (a_B^* - a_A^*)} \cdot [R(a_A^*) + \theta f]
\]

where \( a_A^* \) denotes the broadcaster’s optimal choice of the advertising level.

The public service broadcaster sets \( a_A^* \) to satisfy its FOC given the value for \( a_B \). Compared to the situation of the symmetric equilibrium the modified PSB’s optimality condition comprises an additional effect, \( V_A'(a_A, a_B) \cdot \theta f \). This term represents the change in the PSB’s license fee revenue caused by a change in the station’s viewer share. The PSB’s marginal profit is increasing in \( f \) with \( \frac{\partial^2 u_A}{\partial a_A \partial f} = \frac{\gamma N}{2\tau} \cdot \theta \).

The private broadcaster’s FOC is now

\[
V_B(a_A, a_B) \cdot R'(a_B^*) = \frac{\gamma N}{2\tau} \cdot R(a_B)
\]

\[
R'(a_B^*) = \frac{\gamma}{\tau + \gamma (a_B^* - a_A^*)} \cdot R(a_B^*)
\]

The two FOC determine the solution to the modified advertising quantity game. Solving them explicitly for the choice variables would provide the corresponding reaction functions. Accordingly, for any quantity choice of its rival, let \( b_i(a_j) \) be station \( i \)'s optimal set of quantity choices. Thus, \( b_i(\cdot) \) is station \( i \)'s best response correspondence. A pair of quantity choices \((a_A^*, a_B^*)\) is a Nash equilibrium if and only if \( a_i^* \in b_i(a_j^*) \) for \( i \neq j \) (mixed-strategy solutions are excluded). Hence, the optimal solution is implicitly defined by the rival firm’s choice. From the FOC it becomes clear, that for \( f > 0 \) the equilibrium of the game can no longer be symmetric. Setting equal advertising levels cannot be in the solution set of this game, i.e. \( a_A^* \neq a_B^* \) in equilibrium.

The PSB’s optimality condition points out that for \( f > 0 \) the PSB puts additional weight on its viewer share. The RHS of its optimality condition is strictly and linearly increasing in \( f \).
Thus, the station is put up to attract viewers from its rival. The only way the PSB can attract additional viewers is to lower the advertising level in its program. When $a_A$ is lowered, then the producers’ willingness to pay for advertising increases and $R'(a_A)$ goes up.

Lowering the advertising level has opposing effects on the advertising revenue and the license fee revenue. In equilibrium, the station balances the two effects by choosing the optimal advertising level, $a_A^*$, such that its marginal revenue from advertising equals the marginal cost of exposing its viewers to advertising. The higher the nuisance cost of advertising (large $\gamma$) and the higher the substitutability of the programs (small $\tau$) the easier the PSB can attract viewers from the commercial operator.

Due to the strategic nature of the game, the change of the advertising level by the PSB carries over to the optimal decision of the commercial operator. Because of the lower advertising level in the PSB’s program, the commercial station loses viewers. It turns out that the advertising levels in the two channels have the nature of strategic complements (the cross-derivative of firm $A$’s marginal profit function is strictly positive, i.e. $\frac{\partial^2 \pi_A(a_A, a_B)}{\partial a_A \partial a_B} > 0$, see appendix 8.2).

To get an intuitive insight, consider a loss in viewers faced by the commercial operator due to the measures undertaken by the PSB. If the operator would not react, then its viewers would be exposed to more advertising and even more viewers would switch to the rival channel. Thus, the commercial station lowers its advertising level as well to mitigate the loss of viewers to the PSB. This complementary effect can also be shown by an application of the implicit function theorem (see appendix 8.2). It results in $\frac{\partial a_B}{\partial a_A} > 0$ for all $a_A < a^*_A$.

Because the stations are local monopolists to sell their audience ratings to the advertisers, the commercial station is unable to take over those advertisers that have been excluded from the market by the PSB and vice versa. Competition in the advertising market is degenerated and channels set prices independently. In this game of full information the reaction by the commercial operator was fully anticipated by the PSB and the new asymmetric equilibrium reveals immediately in the markets.

This mechanism is summarized in proposition 1:

**Proposition 1** The introduction of the license fee gives the public service broadcaster an incentive to attract additional viewers by lowering the advertising level in its program. Because ad-
Vertising levels in the two channels are strategic complements, the commercial operator is forced to reduce its advertising as well. However, in the new asymmetric equilibrium the commercial station shows more advertising than the public service broadcaster and has a lower viewer share. (Proof see appendix 8.3)

From the broadcasters’ optimality conditions, one can derive each firm’s per viewer revenue at the optimal point

\[ R(a_A^*) = \left( \frac{\theta}{\gamma} + a_B^* - a_A^* \right) \cdot R'(a_A^*) - \theta f \]

and

\[ R(a_B^*) = \left( \frac{\theta}{\gamma} + a_A^* - a_B^* \right) \cdot R'(a_B^*) \]

where \( R(a_B^*) > R(a_A^*) \) for \( a_B^* > a_A^* \).

Due to the implicit specification of the advertising demand, the optimality conditions cannot be solved explicitly for \((a_A^*, a_B^*)\). However, the advertising levels depend on the amount of the license fee, i.e. \( a_i \) can be expressed as a function of \( f \). Recall that the producers’ willingness to pay is limited from above by type \( \sigma \). Then

\[
a_A(f) = \begin{cases} 
\hat{a} & \text{if } f = 0 \\
 a_A^* & \text{if } 0 < f \leq \sigma \\
 0 & \text{if } f > \sigma 
\end{cases}
\]

Note that here \( a_A = 0 \) is a profit maximizing choice of the PSB and not a ban of advertising imposed by a regulator (for this case see section 6.2).

The advertising level of the commercial broadcaster can be expressed in terms of \( f \) as well. Recall that \( a_B^* > a_A^* \) for all \( f > 0 \). Then

\[
a_B(f) = \begin{cases} 
\hat{a} & \text{if } f = 0 \\
 a_B^* & \text{if } 0 < f \leq \sigma \\
 a_B & \text{if } f > \sigma 
\end{cases}
\]

where \( a_B \) is the advertising level that the commercial operator chooses when the PSB sets an advertising level of zero. Accordingly, the commercial station will always set \( a_B > 0 \).
As can be seen from $a_B(f)$ the commercial station stays in business even if the PSB chooses not to show any advertising. However, the station might be driven out of the market for another reason: The PSB attracts all of its viewers, i.e. $V_A = N$ and $V_B = 0$ (keeping the assumption of full viewer coverage). $V_B \geq 0$ requires for $\gamma > 0$ that

$$\frac{N}{2} \geq \frac{N\gamma}{2\tau} (a_B - a_A)$$

$$a_A \geq a_B - \frac{\tau}{\gamma} \Leftrightarrow a_B \leq a_A + \frac{\tau}{\gamma}$$

Plugging this condition into the viewing demand functions gives $V_A = N$ and $V_B = 0$ when $a_A \leq a_B - \frac{\tau}{\gamma}$. Accordingly, the commercial station is driven out of business when it sets an advertising level that exceeds the PSB’s advertising level by more than $\frac{\tau}{\gamma}$. This mark-up is growing in the program substitutability and shrinking in the nuisance cost of advertising. Thus, $\underline{a}_B \in \left(0, \frac{\tau}{\gamma}\right]$.

An interesting question arising from proposition 1 is, how the two broadcasters’ profits develop due to the introduction of the license fee. It can be shown by the stations’ profit functions that the asymmetric cut in the advertising levels results in a competitive advantage for the PSB, which then derives a higher profit as before. In contrast, the commercial station’s profit falls below the initial level.

**Proposition 2** The public service broadcaster derives a higher profit after the introduction of the license fee, whereas the commercial operator’s profit drops below the level of the symmetric equilibrium.

To see this, assume first that $f = 0$. Then the equilibrium is symmetric with $\pi_A = \pi_B = \hat{\pi}$. When the broadcasters move from the symmetric equilibrium, then the direct marginal effect on the public service broadcaster’s revenue is given by $\frac{\partial \pi_A}{\partial f} = \hat{V}\theta = \frac{N}{2}\theta > 0$. Thus, $\pi_A^* > \hat{\pi}$. As was shown previously, the PSB has an incentive to foster this effect by increasing its viewer share on the detriment of the rival station. For $a_B^* < \hat{a}$ and $a_B^* > a_A^*$ it is clear that $\pi_B^* < \hat{\pi}$. 

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5 Welfare Analysis

Public service broadcasting should only be introduced or continued if it is beneficial to welfare. A government might focus on the welfare of viewers only or take the welfare of all involved agents into consideration, i.e. consider the rents of advertisers and broadcasters as well.

For the case of a symmetric equilibrium with equal viewer shares and no license fees, the sum of viewing and advertising benefits, $W(a)$, can be written as

$$
W(\tilde{a}) = 2 \left[ N \int_0^{1/2} (\beta - \gamma \tilde{a} - \tau \lambda) d\lambda + \frac{N}{2} \int_0^{\tilde{a}} p(a) da \right]
$$

$$
= N \left( \beta - \gamma \tilde{a} - \frac{\tau}{4} \right) + N \int_0^{\tilde{a}} p(a) da
$$

where the first part represents the net benefits of the viewers from watching TV and the latter part represents the gross benefits of the producers from advertising. This part also includes the profits of both broadcasters.

Note that neither part is at a global maximum at the symmetric equilibrium. Viewing benefits are maximized in the absence of any advertising, i.e. $\tilde{a} = 0$, and equal viewers share of $V_A = V_B = N/2$. Then viewing benefits amount to $N \left( \beta - \frac{1}{4} \tau \right)$, where $N\beta$ represents the aggregated gross viewing benefits and $N\sqrt{4}/\tau$ represents the aggregated mismatch costs. Benefits from advertising are maximized if all advertisers that have a positive willingness to pay can put their advertising on the programs. Since in the model there are no costs associated to the broadcasting of advertising messages, the welfare maximizing price is zero.

Accordingly, in any equilibrium at least one party will be away from its welfare level of advertising. There is a unresolvable conflict of interests between viewers and advertisers: Advertisers like viewers but viewers dislike advertisers. Any choice of $a$ results in welfare detrimental effects. A regulator that values the viewers’ and the advertisers’ rents equally will chose $\tilde{a}_{req}$ such that the advertisers’ willingness to pay per viewer is equal to the nuisance cost of advertising, i.e.

$$
\gamma = p(\tilde{a}_{req}).
$$

\footnote{For the case of linear transport costs in a duopoly, the mismatch cost would be the same if both firms settled in the center of the interval. However, in this model the location choice is exogenously at the "addresses" zero and one.}
5.1 Welfare Effects on Viewers

The introduction of the license fee and the move from the symmetric equilibrium to \((a_A^*, a_B^*)\) has overall three different effects on the viewers’ utility. Two of the effects lead to a loss in viewer welfare, whereas one effect increases the benefits from watching television. The gross viewing benefit \(\beta\) is unchanged.

Firstly, the viewers face a loss in utility from paying the mandatory license fee. Recall from the setup that each viewer has to pay \(f\) regardless whether he actually watches the PSB or not. The collected fees amount to \(N \cdot f\). The share \(V_A \cdot \theta f\)\(^{13}\) is transferred to the budget of the public service broadcaster. As long as \(V_A < N\) some part of the total collected amount is left over. I assume that these fees are returned to the viewers in such a way that their decision which station to watch is not impacted. Thus, each viewer’s disutility from the license fee is \(\frac{V_A}{N} \cdot f\). For all viewers the loss amounts to \(V_A \cdot f\). A reasoning for this mechanism was provided in the first part of section 4. Note that an amount of \(N \cdot (1 - \theta) f\) is entirely lost due to the inefficiency of the public authority that collects and distributes the fees. This issue will be picked up again in section 7.1.

The second detrimental effect to welfare is caused by the move from the symmetric equilibrium at which \(V_A = V_B = \frac{N}{2}\). As soon as \(V_A > V_B\) the marginal viewer is pushed away from the middle of the unit interval towards the end at which the commercial broadcaster is located. Each viewer (to the right of the center of the interval) who switches from the commercial station to the public service broadcaster because of the lower level of advertising in the program then faces higher mismatch costs from watching. For linear mismatch costs the aggregate welfare loss increases from \(\frac{\tau}{4} N\) to \(\tau N\) when moving from \(V_A = \frac{N}{2}\) to the extreme case of \(V_A = N\). Thus, the aggregate welfare loss falls into the interval \([\frac{\tau}{4} N, \tau N]\).

In contrast to the first two effects, the third effect enhances welfare. This effect stems from the reduction of advertising in both programs. It was shown that in the new asymmetric equilibrium \(a_A^* < a_B^* < \tilde{a}\). Thus, \(V_A \cdot \gamma a_A^* + V_B \cdot \gamma a_B^* < N \gamma \tilde{a}\).

The effects on the benefits from viewing can be displayed in more detail by separating the viewers into three groups:

\(^{13}\)For the sake of simpler notation I write \(V_i\) for \(V_i(a_i, a_j)\) thereinafter.
• Group 1: Existing viewers of station A (the PSB)

• Group 2: Remaining viewers of station B (the commercial station)

• Group 3: Viewers who switch from the commercial station to the PSB.

5.1.1 Group 1: Existing Viewers of Station A

Among all viewers those who stick to station A benefit most from (or get least harmed by) the introduction of public service broadcasting. The members of this group are allocated within the interval $\lambda \in [0, \frac{1}{2}]$. They suffer from the introduction of the license fee but they benefit from the reduction of advertising in the PSB’s program from $a$ to $a_A^*$. The change in utility is the same for each member of the group and given by

$$\gamma (\hat{a} - a_A^*) = \frac{V_A}{N} f$$

This change is positive if $\gamma (\hat{a} - a_A^*) > \frac{V_A}{N} f$. Thus, the gain in utility from the cut-back of advertising has to be greater than the disutility caused by the net license fee payment. The aggregated change in utility for the group amounts to $\frac{N}{2} \left[ \gamma (\hat{a} - a_A^*) - \frac{V_A}{N} f \right]$. The disutility from the program mismatch does not change for this group of viewers.

5.1.2 Group 2: Remaining Viewers of Station B

Station B loses some part of its viewers, explicitly $N \left( \hat{\lambda} - \frac{1}{2} \right)$ viewers. However, as long as $a_A^*$ and $a_B^*$ are such that $V_B > 0$ some viewers remain with the commercial station. They like the commercial broadcasting so much more than the PSB that they accept the level of advertising in the program. These viewers are of type $\lambda \in \left[ \hat{\lambda}, 1 \right]$. Each viewer who stays with station B faces a change in utility of

$$\gamma (\hat{a} - a_B^*) = \frac{V_A}{N} f$$

which is positive if $\gamma (\hat{a} - a_B^*) > \frac{V_A}{N} f$. In line with the condition for the existing viewers of station A, viewers gain if benefits from the reduction of advertising outweigh the mandatory license fee. The aggregated change in utility for the group is $N \left( 1 - \hat{\lambda} \right) \left[ \gamma (\hat{a} - a_B^*) - \frac{V_A}{N} f \right]$. 

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5.1.3 Group 3: New Viewers of PSB

Some viewers of station $B$ decide to switch to the public service broadcaster because of the lower level of advertising. The viewers of this group are located between the two other groups and are of type $\lambda \in \left[ \frac{1}{2}, \tilde{\lambda} \right]$. They like the lower level of advertising in the PSB’s program so much that they accept the higher program mismatch costs. The number of these viewers is $N \left( \tilde{\lambda} - \frac{1}{2} \right)$. Each of them individually faces a change in utility of

$$\gamma (\tilde{\alpha} - a^*_\lambda) - 2\tau \left( \lambda - \frac{1}{2} \right) - \frac{V_A}{N} f$$

where the term in the middle shows the increase in the viewer’s program mismatch costs. The utility change is positive if $\gamma (\tilde{\alpha} - a^*_\lambda) - 2\tau \left( \frac{1}{2} - \lambda \right) > \frac{V_A}{N} f$. The LHS is dependent on the viewer’s location with $(\lambda - \frac{1}{2}) > 0$ for $\lambda \in \left[ \frac{1}{2}, \tilde{\lambda} \right]$.

For the first two groups the direction of the change is unique within the group, e.g., all existing viewers of station $A$ are either better off or worse off. For the members of the third group this is not true. It might be that some fraction of this group faces an increase in its utility whereas the rest of the viewers faces a decrease in its utility.

To see this, consider the following example: Assume that $\gamma a^*_A + \frac{V_A}{N} f < \gamma \tilde{\alpha} < \gamma a^*_B + \frac{V_A}{N} f$. Under these circumstances the members of the first group, the existing viewers of station $A$, are all better off by the introduction of the license fee transfers. The members of second group, the remaining viewers of the commercial station, are all worse off. But what happens to the viewers who have switched to the PSB? The answer: Some do benefit, some do not. The marginal viewer in this group is located at $\tilde{\lambda} = \frac{1}{2} + \frac{1}{2\tau} \left[ \gamma (\tilde{\alpha} - a^*_\lambda) - \frac{V_A}{N} f \right]$. Thus, viewers in the interval $\lambda = \left[ \frac{1}{2}, \tilde{\lambda} \right]$ are better off and viewers in the interval $\lambda = \left[ \tilde{\lambda}, \tilde{\lambda} \right]$ are worse off.

For that reason the utility change can not be aggregated as for the first two groups. Alternatively, consider the following: All viewers in the group are better off if

$$N \int_{\frac{1}{2}}^{\tilde{\lambda}} u (a^*_\lambda, f, \lambda) \, d\lambda - N \int_{\frac{1}{2}}^{\tilde{\lambda}} u (\tilde{\alpha}, \lambda) \, d\lambda > 0$$

which can be transformed into a condition in line with the first two groups of viewers and
independent of $\lambda$ as

$$
\gamma (\hat{a} - a^*_A) - \frac{\gamma}{2} (a^*_B - a^*_A) > \frac{V_A}{N} f
$$

The results can be summarized as follows: The viewers in the different groups are better off by the introduction of license fee transfers if the following conditions hold true:

$$
u(a^*_i, f, \lambda) > \nu(\hat{a}, \lambda)$$

if

$$
\begin{aligned}
&\gamma (\hat{a} - a^*_A) > \frac{\gamma}{N} f & \text{for } \lambda \in [0, \frac{\hat{\lambda}}{2}]
\\&\gamma (\hat{a} - a^*_B) > \frac{\gamma}{N} f & \text{for } \lambda \in [\hat{\lambda}, 1]
\\&\gamma (\hat{a} - a^*_A) - \frac{\gamma}{2} (a^*_B - a^*_A) > \frac{\gamma}{N} f & \text{for } \lambda \in [\frac{1}{2}, \hat{\lambda}]
\end{aligned}
$$

The second and the third condition in this statement both imply the first because $a^*_A < a^*_B$. The first group, the old viewers of station $A$, do best under all circumstances.

In contrast, it is not obvious whether the second or the third group is more likely to gain. The third condition can be modified to $\gamma (\hat{a} - a^*_A - a^*_B) > \frac{\gamma}{N} f$ where the LHS is greater than $\gamma (\hat{a} - a^*_B)$ because $\frac{a^*_B}{2} + \frac{a^*_A}{2} < a^*_B$. Thus, the viewers in the second group do always better than the viewers in the third group. Accordingly, those viewers who like the commercial station’s program the most, benefit least (or are harmed most, respectively) by the introduction of mix-funded public service broadcasting. These results are displayed by the following proposition:

**Proposition 3** By the introduction of mix-funded public service broadcasting, the viewers who stick to the PSB benefit most (or are harmed least, respectively), followed by the viewers who switch from the commercial station to the PSB. The remaining viewers of the commercial station benefit least (or get harmed most, respectively).

Given this insight, three cases can be distinguished.

- **Case 1:** All viewers are better off
- **Case 2:** All viewers are worse off
- **Case 3:** Mixed effects
5.1.4 Case 1: All viewers better off

All viewers are better off if the condition $\gamma a^*_B + \frac{V_A}{N} f < \gamma \hat{a}$ is fulfilled. In this case the license fee is low compared to the gain of viewers from the cutback of advertising in the programs. The condition assures that all remaining viewers of the commercial station benefit from the introduction of the license fee system. At the same time, this condition implies that all old viewers of station $A$ and all viewers who switched to the PSB are better off as well.

5.1.5 Case 2: All viewers worse off

This case arises if $\gamma a^*_A + \frac{V_A}{N} f > \gamma \hat{a}$. The old viewers of station $A$ do not gain which in turn implies that none of the other two groups of viewers benefits. In this case the license fee is high compared to the utility gain from the reduction of advertising.

5.1.6 Case 3: Mixed effects

Case one and two are both clear cut. The utility change of all viewers is directed into the same direction, either they all gain or they all lose. Such a unique result is not assured. It could well be that some viewers benefit whereas other viewers lose. Mixed effects arise if $\gamma a^*_A + \frac{V_A}{N} f < \gamma \hat{a} < \gamma a^*_B + \frac{V_A}{N} f$. The group of old viewers of station $A$ is better off. In contrast, each viewer who remains with the commercial station faces a loss in utility. The effect on viewers who switch is two-fold.

5.1.7 Aggregate Effect on Viewers

In line with the presentation of the net viewing benefits in the symmetric case, net viewing benefits in the asymmetric equilibrium, $B_V (a^*_A, a^*_B)$, can be written as

$$B_V (a^*_A, a^*_B) = N \int_0^\lambda \left( \beta - \gamma a^*_A - \frac{V_A}{N} f - \tau \lambda \right) d\lambda$$

$$+ N \int_\lambda^1 \left( \beta - \gamma a^*_B - \frac{V_A}{N} f - \tau (1 - \lambda) \right) d\lambda$$

The first term on the RHS shows the net viewing benefits for the viewers of the public service broadcaster (including those viewers who switched), whereas the second term shows the net
viewing benefits for the viewers of the commercial station. Recall that \( \hat{\lambda} = \frac{1}{2} + \frac{1}{2\tau} \gamma (a_B - a_A) > \frac{1}{2} \) for \( a_A^* < a_B^* \). By integration the equation can be simplified to

\[
BV(a_A^*, a_B^*) = N \left[ \beta - \frac{V_A}{N} f - \frac{1}{4\tau} - \frac{\gamma}{2} (a_A^* + a_B^*) + \frac{\gamma^2}{4\tau} (a_B^* - a_A^*)^2 \right]
\]

The benefits of the viewers are dependent on \( a_A^* \) and \( a_B^* \). However, the advertising levels enter the viewing welfare in two ways: Firstly, by the term \(-\frac{\gamma}{2} (a_A^* + a_B^*)\). Accordingly, the larger the cutback in both stations’ advertising the larger the utility gain of the viewers. Secondly, by the term \(\frac{\gamma^2}{4\tau} (a_B^* - a_A^*)^2\). This term represents the welfare improvement caused by viewers who switch from the commercial station to the PSB. Even though they face an increase in the program mismatch costs they gain from the lower advertising level in the PSB’s program. The further the marginal viewer \( \hat{\lambda} \) is pushed towards the commercial station’s location, the larger is the utility gain. Put differently, welfare increases when the commercial station’s viewer share falls. This effect is weakened by the substitutability parameter \( \tau \).

Now, consider the question if the net viewing benefits increase, decrease or stay unchanged when the license fee transfers are imposed on the viewers. Viewer benefits increase compared to the symmetric case if \( BV(a_A^*, a_B^*) > BV(\bar{a}) \) which holds true if

\[
\gamma \left( \bar{a} - \frac{1}{2} (a_A^* + a_B^*) + \frac{\gamma}{4\tau} (a_B^* - a_A^*)^2 \right) > \frac{V_A}{N} f
\]

The effects on the viewers’ utility are summarized in the following proposition:

**Proposition 4** The net benefits of viewers increase after the introduction of public service broadcasting if the license fee payment is such that

\[
\gamma \left( \bar{a} - \frac{1}{2} (a_A^* + a_B^*) + \frac{\gamma}{4\tau} (a_B^* - a_A^*)^2 \right) > \frac{V_A}{N} f
\]

Accordingly, viewers are more likely to gain utility if the license fee payment is (1) small in relation to the cut-back of the advertising levels, \( \bar{a} - \frac{1}{2} (a_A^* + a_B^*) \), and (2) small in relation to the spread in the two stations’ advertising level, \( a_B^* - a_A^* \).

Thus, overall viewing benefits increase if the sum of the aggregated disutility from the license
fee and the additional program mismatch are less than the aggregated utility gain from the reduction in advertising.

5.2 Welfare Effects on Advertisers and Broadcasters

Under the asymmetric framework aggregate advertising benefits, $B_A (a_A^*, a_B^*)$, generated by the broadcasters are

$$B_A (a_A^*, a_B^*) = V_A \int_0^{a_A^*} p (a_A) \, da_A + V_B \int_0^{a_B^*} p (a_B) \, da_B$$

The first term on the RHS represents the advertising benefits generated by the public service broadcaster, whereas the second term shows the advertising benefits generated by the commercial station. Note that $B_A (a_A^*, a_B^*)$ includes the share of advertising benefits which ends up with the broadcasters, i.e. $V_A \cdot R (a_A^*)$ and $V_B \cdot R (a_B^*)$.

So far, the welfare aggregation is as usual: The producers (here the broadcasters) get the revenue "quantity times price" and the consumers (here the advertisers) get the value corresponding to the remaining area under the demand curve. One complication is caused by the fact that the PSB has an additional revenue source, the license fee transfers. Thus, to get the total benefits of advertisers and broadcasters, the fees $V_A \cdot \theta f$ that are used up by the PSB have to be added to welfare.

At the asymmetric equilibrium, the benefits from advertising are strictly less than in the symmetric case. Some firms that bought advertising slots in the symmetric framework are now excluded from the market.

**Proposition 5** Mix-funded public service broadcasting reduces the amount of advertising in both channels compared to the case of pure commercial broadcasting. For a number of $(2 \hat{a} - a_A^* - a_B^*)$ firms advertising is no longer profitable. They are excluded from the advertising market and their rent is lost. The higher the license fee, the stronger the stations’ cut-back of advertising and the higher the welfare loss in the advertising market.

To see this, recall that in the asymmetric equilibrium $a_A^* < a_B^* < \hat{a}$ and $R (a_A^*) < R (a_B^*) < R (\hat{a})$. Then

$$N \cdot R (\hat{a}) > V_A \cdot R (a_A^*) + V_B \cdot R (a_B^*)$$
which is true because for $N = V_A + V_B$ it strictly holds that

$$V_A \cdot [R(\tilde{\alpha}) - R(a^*_A)] + V_B \cdot [R(\tilde{\alpha}) - R(a^*_B)] > 0$$

Note, that the size of the welfare loss depends on the slope of the per viewer advertising demand curve, $p(a)$. The welfare detrimental effect is small if the advertising demand is curve is flat and vice versa. According to the model, advertising prices are higher and quantities are lower in countries in which PSB is mix-funded.

The overall effect on both producers and broadcasters could be positive if the license fee transfer to the PSB, $V_A \cdot \theta f$, is larger than the loss of advertising benefits. Thus, the overall welfare effect on advertisers and broadcasters is negative if

$$V_A \left[ \int_0^a p(a) \, da - \int_0^{a_A} p(a_A) \, da_A \right] + V_B \left[ \int_0^a p(a) \, da - \int_0^{a_B} p(a_B) \, da_B \right] - V_A \cdot \theta f > 0$$

### 5.3 Effects on Overall Welfare

In the two preceding sections the welfare effects of the introduction of mix-funded public service broadcasting on viewers as well as on advertisers and broadcasters were analyzed separately. Now, the overall welfare effect will be evaluated.

Using the welfare conditions from above, overall welfare is enhanced if

$$\gamma \left( \tilde{\alpha} - \frac{1}{2} (a^*_A + a^*_B) + \frac{\gamma}{2 \tau} (a^*_B - a^*_A)^2 \right) - \left( \frac{1}{2} + \frac{\gamma}{2 \tau} (a^*_A + a^*_B) \right) \left[ \int_0^{\tilde{\alpha}} p(a) \, da - \int_0^{a_A} p(a_A) \, da_A \right] - \left( \frac{1}{2} - \frac{\gamma}{2 \tau} (a^*_A + a^*_B) \right) \left[ \int_0^{\tilde{\alpha}} p(a) \, da - \int_0^{a_B} p(a_B) \, da_B \right] - \frac{\gamma}{N} \cdot f (1 - \theta) > 0$$

The first line reproduces the change in the viewers’s utility (net of license fee transfers), the
second and third line display the loss in the advertising market, and the fourth line shows the net efficiency loss of the PSB license fee transfers. If the sum of these three elements is greater than zero then overall welfare is enhanced by the introduction of the PSB system.

The effects displayed in the lines 2-4 reduce overall welfare. Advertising benefits are lost and the redistribution of license fees causes a loss as well. Thus, the PSB system can enhance overall welfare only if viewer benefits increase. Note that the parameters $\gamma$ and $\tau$ enter both the expressions for viewing and advertising benefits. As such their effects are ambiguous.

6 Extensions and Applications

In the following section the basic model will be extended and applied in order to approach a number of policy relevant questions, that arise in the context of mix-funded public service broadcasting. Firstly, the financing mechanism of the PSB and the related welfare loss (see section 5.1) are discussed in the light of the example of Germany. Then the effects of advertising ceilings are considered. Finally, a scenario is analyzed in which both stations choose identical program agendas.

6.1 PSB Financing mechanism

As stated in the welfare analysis, the financing of the public service broadcaster leads to an unambiguous welfare loss caused by costs for collecting and distributing the license fees and for monitoring the ownership of TV sets. The level of this loss is measured by the efficiency parameter $\theta \in [0, 1]$. The regulator has the duty to keep $\theta$ close to one by designing the public fees system as efficient as possible.

The significance of the welfare loss can be displayed by the example of Germany. In Germany, license fees are collected by a public authority called "Gebührenzentrals" (GEZ). The authority collected a total of 6.75 billion Euros of fees in 2002 for 41 million registered radio sets and 36 million registered TV sets.\(^{14}\) In the same year, the authority was run on the basis of more than 1,200 employees and spent 121 million Euros for its operations. As such, 1.8 per cent

\(^{14}\)Figures taken from the authority’s annual report 2002, which can be downloaded from the authority’s website at www.gez.de.
of the total fees were expended for administrative activities.

This welfare loss for the TV viewers could be avoided if the authority was abolished and the
PSB in Germany were financed by the government’s general budget as in Spain, Portugal or the
Netherlands. From the middle of the nineties, in Germany about 98 per cent of the population
lives in a household that has access to a TV set.\textsuperscript{15} Under such circumstances, monitoring the
ownership of TV sets seems pointless. In addition, there is serious concern that the activities
of the GEZ harm the privacy of viewers. For example, the GEZ has access to local registration
data of citizens, that it then compares to the registration of TV sets. Moreover, the behavior of
the GEZ’s investigators to detect unlicensed viewers are highly disputed.

A serious concern about financing PSB activities by the general budget is the independency
of the program from political influence. This has to be assured by the broadcasting framework.
In Germany, for example, the PSB budget planning is to be confirmed by a council of finance
and media experts, the "Kommission zur Ermittlung des Finanzbedarfs der Rundfunkanstalten"
(KEF). Such a safeguard could be sufficient. Another serious issue is the production efficiency
of the public service broadcaster. In its 13th report the KEF expressed the opinion that fur-
ther opportunities of saving overhead costs existed in several PSB units in Germany in 2001.\textsuperscript{16}
However, the question of efficiency can not be answered in the absence of production cost and
technology, which are out of the scope of this model.

\subsection{Advertising Ceilings}

Upper ceilings on advertising levels are a common regulatory feature of television markets in the
EU, e.g. in Denmark, Germany, and France. Assume now that the public service broadcaster
can no longer choose the advertising level in its program itself. Instead, the regulator imposes a
maximum level of advertising, $a_{\text{reg}}$, on the broadcaster. The rule is only binding when it is set
below the advertising level that would be chosen by the broadcaster in absence of the regulation,
i.e. $a_{\text{reg}} < a^*_A$.

The equilibrium is now determined by the regulator’s rule and the corresponding choice of
\textsuperscript{15}see: Medien Basisdaten 2004. In: Media Perspektiven. Available online from the website http://www.ard-
werbung.de/mp/publikationen/basisdaten/.
176. Downloaded from www.kef-online.de.
the advertising level of the commercial station. If the regulator imposes an advertising ceiling such that \( a_{reg} < a^*_A \) then it follows that \( a_B \) will fall below \( a^*_B \), because the advertising levels are strategic complements. Thus, if \( f \) is unchanged then the advertising ceiling reduces the profits of both stations and drives the rent of the advertisers further down. In contrast, viewers benefit unambiguously from the advertising ceiling because of the lower quantity of advertising they are exposed to. The regulator may use advertising ceilings to limit the profits of the PSB. However, the profits of the commercial station are reduced even more. An advertising ceiling may be recommended if a regulator cares more about viewer benefits than about rents from advertising.

A special case of an advertising ceiling is the ban of advertising in the PSB’s program, i.e. \( a_{reg} = 0 \). The PSB’s profit function is modified to \( \pi_A = V_A(a_B) \cdot \theta f \) where \( V_A(a_B) = N \left( \frac{1}{2} + \frac{\gamma}{2\tau} a_B \right) \) and \( V_B(a_B) = N \left( \frac{1}{2} - \frac{\gamma}{2\tau} a_B \right) \). Accordingly, viewing demand becomes more elastic with respect to advertising in the commercial station. The commercial operator chooses the advertising level from the interval \( a_B \in \left( 0, \frac{\tau}{2\gamma} \right) \) such that its marginal revenue fulfills \( R'(a_B) = \frac{1}{\tau - \gamma a_B} \cdot R(a_B) \). Now, the RHS is unambiguously increasing in \( \gamma \). Thus, the smaller the nuisance cost of advertising are the less the commercial station is hurt by the advertising ban.

6.3 No Program Differentiation

In the model there is no endogenous location choice of the firms. So far it was assumed that the broadcasters are ex-ante located at the extremes of the unit interval, zero and one. These "addresses" provide the maximum level of product differentiation. The other extreme, i.e. no product differentiation, is obtained if both broadcasters settle at the same position on the interval. Here a case will be analyzed, in which both firms settle in the center of the interval.

Assume that both broadcasters are located at position \( \frac{1}{2} \). Then a type-\( \lambda \) viewer obtains a utility from watching station \( A \) of

\[
\begin{align*}
 u_A(\lambda, a_A) = \begin{cases} 
 \beta - \gamma a_A - \tau \left( \frac{1}{2} - \lambda \right) - f & \text{if } 0 \leq \lambda < \frac{1}{2} \\
 \beta - \gamma a_A - f & \text{if } \lambda = \frac{1}{2} \\
 \beta - \gamma a_A - \tau \left( \lambda - \frac{1}{2} \right) - f & \text{if } \frac{1}{2} < \lambda \leq 1 
\end{cases}
\end{align*}
\]

(analogously from watching channel \( B \)). If \( a_A = a_B \), then all viewers are indifferent between the
two stations and will randomize which station to watch.

As soon as $a_i < a_j$ station $i$ attracts all viewers and nobody watches station $j$. Thus, in the absence of costs and collusion, the competition between the stations will drive the advertising levels down to zero (similar to the case of Bertrand price competition). The only stable equilibrium is $a_A = a_B = 0$. At such an equilibrium the public service broadcaster will still receive fees of $V_A \cdot \theta f$, i.e. $\pi_A > 0$. In contrast, the commercial station will lose all of its advertising revenues and make zero profits. Put differently, the commercial broadcaster is eliminated from the market. By program duplication the public service broadcaster can capture the entire viewing market.

**Proposition 6** In the absence of program differentiation competition between the two stations drives both advertising levels down to zero. Until the equilibrium of $a_A = a_B = 0$ is reached, the two stations undercut each other to attract the rival’s viewers. In the equilibrium the commercial station is eliminated from the market, whereas the public service broadcaster can attract all viewers. Thus, the public service broadcaster has an incentive to duplicate the commercial station’s program agenda.

An example for such behavior is given by the German public service broadcaster ARD. The station is allowed to broadcast advertising only in a time slot between five and eight o’clock p.m.. In this slot the ARD presents a game show, a people news magazine, and soap operas. As such, the station duplicates the commercial stations’ program agenda and may abuse public funds for such activities. This mechanism calls for the regulator to make sure that the public service broadcaster does not duplicate the commercial station’s program. The public service broadcaster needs a distinct, clear-cut program agenda that differs from that of commercial stations. In particular, the PSB shall target those viewers that are undersupplied by the commercial stations or not supplied at all. If the PSB is allowed to replicate the commercial TV’s program agenda then the commercial station’s survival is considerably threatened.

**7 Conclusion**

The paper addresses the economic consequences in the viewer and advertising markets caused by public funding of broadcasting in the European Union. It is demonstrated that the introduction
of license fee transfers does not imply per se a welfare improvement but causes a number of ambiguous effects on viewers, advertisers, and broadcasters. Depending on the relation between the level of the license fee, the nuisance cost of advertising, the substitutability between the two channels, and the demand curve for advertising overall welfare may increase or decrease.

The viewers suffer a welfare loss from the mandatory payment of the license fee. In contrast, they all enjoy the reduced level of advertising in the two channels. In addition, some viewers benefit from switching from the commercial station to the public service broadcaster. The overall effect on viewers is ambiguous: I am able to describe cases in which all viewers gain welfare, cases in which all viewers loose welfare and cases in which some viewers gain and some loose welfare. However, the viewers of the public service broadcaster benefit most (or are harmed least) from the license fee transfers.

In contrast, the effect on the advertising market is clear-cut: The two stations reduce the number of advertising spots in their programs to balance the detrimental effect of the license fee on the viewers. Thus, some advertisers no longer find it profitable to buy advertising slots. They are excluded from the market and their rent is lost. Furthermore, the effects on the two broadcasters are opposed. The commercial station looses both viewers and advertising revenues and is unambiguously worse off. In contrast, the public service broadcaster benefits from the license fee. It can attract viewers from the rival station and receives a higher income. In the light of these results, the complaints from commercial broadcasters in the European Union are certainly legitimate.

In addition, the model points out that if nearly each household possesses a TV set, a model of license fee transfers as it is present in most EU member states cannot be optimal. Instead, public broadcasting activities should be financed from the state’s general budget. By this means welfare losses stemming from collecting and distributing the fees and from monitoring the ownership of TV sets could be prevented.

It is clear that market distortions cannot be avoided by any broadcasting system as long as the different types of stations coexist. Even if the PSB is not allowed to broadcast advertising, it will still attract at least some of the viewers from the commercial stations. However, if a government decides to finance broadcasting by public funds then a regulator (e.g. the European Commission) has to assure that such a station provides a service of general economic interest that
is not delivered by commercial stations. The model shows that public service broadcasting needs a clear-cut program remit. Otherwise, publicly funded stations have an incentive to penetrate the viewer markets of commercial stations by duplicating their program agenda.
8 Appendix

8.1 SOC and Uniqueness of the Solution for $a_i = \hat{a}$

In the symmetric setup, the SOC of the broadcasters’ objective function is

$$\frac{\partial^2 \pi}{\partial \hat{a}^2} = 2 \cdot V'(a) \cdot R'(a) + V(a) \cdot R''(a)$$

The SOC is strictly less than zero for $a < \hat{a}$ because $R''(\hat{a}) \leq 0$. Thus, the profit function is strictly concave in $a$ for $a = \hat{a}$.

Under a symmetric setup the cases $a_i = 0$ and $a_i < a_j$ can never be optimal. They will always emerge to the symmetric equilibrium. To see this, firstly, consider the case that $a_A = a_B = 0$. Then $V_A = V_B = \frac{N}{2}$ and $\pi_A = \pi_B = 0$. This is a not stable equilibrium. Each firm has an incentive to sell a first unit of advertising by setting $a$ such that $p(a) = \bar{p}$. Since there are no inframarginal units, no costs are attached to the increase in $a$. Secondly, consider the case that $a_A = 0$ and $a_B > 0$. Then $V_A > V_B$ and $\pi_A = 0$. Firm $A$ now has an incentive to increase the level of advertising in its program. Finally, both firms will choose the level of advertising such that the optimality conditions above are fulfilled and $V_A = V_B$. Deviations from the equilibrium never pay because the marginal cost of deviating is higher then the marginal revenue. Thus, the equilibrium is unique and corner solution cannot occur.

8.2 Strategic Complementarity of Advertising Levels

The optimal value of $a_A$ is implicitly defined by the optimal value of $a_B$ and vice versa, i.e. $a^*_A = b_i(a^*_B)$. Hence, the implicit function theorem gives the answer as

$$\frac{da_B}{da_A} = \frac{\frac{\partial^2 \pi(a_A,a_B)}{\partial a_A^2}}{\frac{\partial^2 \pi(a_A,a_B)}{\partial a_A \partial a_B}}$$
Recall that
\[
\frac{\partial \pi_A(a_A, a_B)}{\partial a_A} = p(a_A) \cdot V_A(a_A, a_B) + \frac{\partial p(a_A)}{\partial a_A} \cdot V_A(a_A, a_B) \\
+ \frac{\partial V_A(a_A, a_B)}{\partial a_A} \cdot p(a_A) a_A + \frac{\partial V_A(a_A, a_B)}{\partial a_A} \cdot \theta f \\
= V_A \cdot R'(a_A) + \frac{\partial V_A}{\partial a_A} [R(a_A) + \theta f]
\]

then
\[
\frac{\partial^2 \pi_A(a_A, a_B)}{\partial a_A^2} = 2 \frac{\partial p_A}{\partial a_A} \cdot V_A + 2 \frac{\partial V_A}{\partial a_A} \cdot p_A \\
+ 2 \frac{\partial p_A}{\partial a_A} \cdot \frac{\partial V_A}{\partial a_A} \cdot a_A + \frac{\partial^2 p_A}{\partial a_A^2} \cdot V_A a_A \\
= 2 \frac{\partial V_A}{\partial a_A} \cdot R'(a_A) + V_A \cdot R''(a_A)
\]

and
\[
\frac{\partial^2 \pi_A(a_A, a_B)}{\partial a_A \partial a_B} = \frac{\partial V_A}{\partial a_B} \cdot p_A + \frac{\partial p_A}{\partial a_B} \cdot \frac{\partial V_A}{\partial a_A} \cdot a_A \\
= \frac{\partial V_A}{\partial a_B} \cdot R'(a_A)
\]

Combining these results it can be shown that
\[
\frac{da_B}{da_A} = -2 \frac{\partial p_A}{\partial a_A} \cdot V_A + 2 \frac{\partial V_A}{\partial a_A} \cdot p_A \\
+ \frac{\partial^2 p_A}{\partial a_A^2} \cdot V_A a_A + 2 \frac{\partial p_A}{\partial a_B} \cdot \frac{\partial V_A}{\partial a_A} \cdot a_A \\
\frac{\partial V_A}{\partial a_B} \cdot p_A + \frac{\partial p_A}{\partial a_B} \cdot \frac{\partial V_A}{\partial a_B} \cdot a_A \\
= -2 \frac{\partial V_A}{\partial a_B} \cdot R'(a_A) + V_A \cdot R''(a_A)
\]

The denominator is strictly positive for \(R'(a_A) > 0\). Thus, for \(\frac{da_B}{da_A} > 0\) it is necessary that the nominator is negative, i.e.
\[
\frac{2 \partial V_A}{\partial a_A} R' (a_A) + V_A \cdot R'' (a_A) < 0
\]
\[
V_A \cdot R'' (a_A) < \frac{2N}{2\tau} \cdot R' (a_A)
\]
which is always true because \( R'' (a_A) \leq 0 \) and \( R' (a_A) > 0 \) for all \( a < \tilde{a} \), where \( \tilde{a} \) is the advertising level that maximizes \( R (a) \) s.t. \( R' (a) = 0 \).

8.3 Proof of Proposition 1

The fact that \( a_A^* < \tilde{a} \) follows directly from the PSB’s optimality condition. The fact that \( a_B^* < \tilde{a} \) if \( a_A^* < \tilde{a} \) was demonstrated by the application of the implicit function theorem. The proof that \( a_A^* < a_B^* \) is now given by contradiction. Subtracting the two optimality conditions results in

\[
V_A (a_A, a_B) \cdot R' (a_A) - V_B (a_A, a_B) \cdot R' (a_B) = \frac{N}{2\tau} \cdot [R (a_A) - R (a_B) + \theta f]
\]

Assume that \( a_A > a_B \). Then it follows from the concavity of advertising demand that \( V_A (a_A, a_B) \cdot R' (a_A) < V_B (a_A, a_B) \cdot R' (a_B) \). Thus, the LHS is strictly positive. However, \( a_A > a_B \) also implies that \( R (a_A) > R (a_B) \). The RHS is strictly greater than zero. Hence, for \( f > 0 \) it can only be true that \( a_A^* < a_B^* \). The PSB sets a lower advertising level in equilibrium. Finally, under the assumption of full viewing coverage it follows from the viewing demand functions that \( V_A (a_A^*, a_B^*) > V (\tilde{a}) > V_B (a_A^*, a_B^*) \).
References


