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Are commercial ceilings appropriate for the regulation of free-to-air TV channels?

By Julia Rothbauer and Gernot Sieg*

Commercial ceilings not only restrict broadcasters in their decisions about commercial broadcasting time, but also affect their differentiation of program content. This study examines the welfare effects of commercial ceilings in a two-sided free-to-air TV market, taking into account welfare with respect to content differentiation. We identify a second-best commercial ceiling that maximizes welfare in the absence of enforceable program content regulation and identify the situations in which laissez faire is optimal. The deregulation of commercial broadcasting can improve welfare, even if the laissez-faire level of commercial broadcasting time is excessive.
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I. Introduction

Free-to-air TV depends on the broadcasting of commercials to finance its content, but viewers often dislike commercials and complain about the excessive number of commercials. In Europe, commercial broadcasts are regulated through Directive 2010/13/EU "on the coordination of certain provisions laid down by law, regulation or administrative action in Member States concerning the provision of audiovisual media services" (Audiovisual Media Services Directive). In this directive, the European Commission and the European Parliament state why the EU regulates the TV market and the policy goals of the regulation.

The Treaty on the Functioning of the European Union requires the Union to take cultural aspects into account in its actions under other provisions of that Treaty, in particular in order to respect and promote the diversity of its cultures (Article 167(4) of the Treaty on the Functioning of the European Union). Furthermore, the EU considers the TV market as special because "Audiovisual media services are as much cultural services as they are economic services. Their growing importance for societies, democracy in particular by ensuring freedom of information, diversity of opinion and media pluralism education and culture justifies the application of specific rules to these services." ((5) of the Directive 2010/13/EU). Therefore "EU Member States shall ensure, where practicable and by appropriate means, that broadcasters reserve at least 10% of their transmission time [...] for European works [...]" (Article 17). In addition, the EU restricts the proportion of time allowed for commercials to 20% in any given hour (Article 23).

Free-to-air TV programs differ in the content they broadcast, and viewers differ in the content that they like, such as the proportion and depth of news and the type of entertainment they prefer. Restrictions aimed at improving content

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differentiation are difficult to enforce in practice. Whereas European works can be defined as content originating in Member States, the regulation of other types of content, for example the depth of news, seems to be almost impossible. Compared to content regulations, enforcing the restriction of commercial broadcasting time is easy. However, the new directive has changed track compared to the past. "Given the increased possibilities for viewers to avoid advertising through the use of new technologies such as digital personal video recorders and increased choice of channels, detailed regulation with regard to the insertion of spot advertising with the aim of protecting viewers is not justified. While the hourly amount of admissible advertising should not be increased, this Directive should give flexibility to broadcasters with regard to its insertion where this does not unduly impair the integrity of programmes." ((85) of Directive 2010/13/EU) The governments of the internal German states (Länder) have used the scope for deregulation offered by the loosened EU Directive claiming that they want to improve the financial opportunities of commercial Free-to-air TV channels.

To summarize, the European Union regulates commercial communication in order to promote the diversity of programmes and to protect consumers. Even though viewers may suffer from commercial overload and content duplication, in the European Union, commercial broadcasting rules are being loosened, whereas content regulation remains unchanged (but negligible).

From a theoretical point of view, the number of commercials and the differentiation of channels in an unregulated free-to-air TV market may be excessive, efficient, or insufficient. Between free-to-air TV channels, however, content and commercial broadcasting time are the two most important elements of competition. Regulating commercial broadcasting time may therefore influence the content decision of channels. Binding commercial ceilings intensify content competition and reduce content differentiation (Anderson, 2007). A policy that only considers market failure due to commercials, and neglects market failure due to differentiation, is prone to failure.

This paper identifies market failure in a two-sided free-to-air TV market, and derives a policy to remedy to such failure. Excessive broadcasting of commercials in an unregulated market is not a sufficient condition to justify commercial ceilings. The negative effects of commercial ceilings, which include less content differentiation, may exceed the positive effect of improving the welfare from commercials. Because commercial broadcasting and content differentiation are intertwined, only a comprehensive welfare analysis can determine whether or not commercial ceilings are appropriate.

The general interdependence between commercial broadcasting time and program content differentiation has been analyzed by several authors. Steiner (1952) shows that content duplication is likely to occur in the broadcasting industry, because stations maximize the number of listeners in order to generate advertising revenue. In a free-to-air TV duopoly, Gal-Or and Dukes (2003) also find that channels have incentives to minimize differentiation. In their model reduced differentiation benefits stations, because it increases the price of advertising slots by reducing the equilibrium commercial broadcasting time. In the two-sided market model of Gabszewicz, Laussel and Sonnac (2004), the program mixes of channels never converge given that viewers dislike commercials, but channel profiles become closer as advertising aversion becomes stronger.

Our model builds on the seminal paper of Anderson and Coate (2005) and closely follows the approach of Peitz and Valletti (2008), who compare pay-TV and free-to-air TV with respect to commercial broadcasting time and differentiation. The latter show that free-to-air TV provides less content differentiation. The advertising intensity is greater under free-to-air TV. When the advertising aversion of viewers is strong, commercials are overprovided in the free-to-air TV market. In this case, Peitz and Valletti (2008) support commercial ceilings, whereas they find no reason to adopt commercial ceilings under pay-TV. We provide a welfare analysis of commercial ceilings for free-to-air TV. Taking the effects of a commercial ceiling on differentiation into account, the welfare effects of ad ceilings are ambiguous. We identify the conditions under which commercial ceilings are justified.[1]

Several authors have focused on the regulation of commercial broadcasting time. Richardson (2006) studies the welfare consequences of a commercial ceiling in a model similar to those of Gal-Or and Dukes (2003) and Gabszewicz, Laussel and Sonnac (2004), and concludes that commercial ceilings always reduce welfare. However, in his model, advertising has no effect on aggregate welfare. Our study overcomes this drawback by assuming that advertising can both positively or negatively affect welfare, and it identifies conditions for welfare-improving commercial ceilings.

Anderson (2007) provides a comprehensive analysis of the regulation of television advertising. In his model, the welfare-maximizing broadcasting time for commercials is either zero or infinite, and differentiation is always socially excessive in the free-market equilibrium. As in Peitz and Valletti (2008) our approach indicates that the laissez faire channel differentiation may either be excessive or insufficient. Furthermore, we identify welfare-maximizing advertising levels that are consistent with existing free-to-air TV markets. Whereas Anderson (2007) also analyzes potential quality reduction and bans of specific products, we focus on the trade-off between welfare from advertising and welfare from content.

Recent studies have focused on the asymmetric regulation of commercial broadcasting time. Greiner and Sahm (2011) analyze symmetric and asymmetric advertising bans in two-sided media markets, using a framework of quality-differentiated pay-TV channels with exogenously given quality. They show that an advertising ban in a high-quality medium can reduce the equilibrium reception of high-quality content. Whereas they identify the unintended impact regarding quality, we study the unintended impact regarding content differentiation. Stühmeier and Wenzel (2012) analyze a mixed duopoly in which private and public broadcasters compete. They focus on asymmetric regulation in which the public broadcaster is more heavily regulated than the private channel, and show that the private channel may benefit from asymmetric regulation. However, they assume that TV channels are unable to change the content they offer and therefore do not analyze the effect of commercial ceilings on content differentiation.

II. Model

There are two private broadcasters, each broadcasting on one channel. In the first stage of the game, broadcasters decide on program content. The type of program content is in [0,1] and is, for example, defined by the fraction and thus the depth of news programs included. The location of the first broadcaster is denoted

[1]Our approach is similar to that of Choi (2006). Whereas we focus on content differentiation, he takes the effects of a given advertising level on entry into account and thereby derives a second-best advertising level.

by d_1, with $0 \leq d_1 \leq 1$, and the location of the second broadcaster by $1 - d_2$, with $0 \leq d_2 \leq 1$ (Peitz and Valletti, 2008). After choosing these locations, which, in the model, are equivalent to program content, in the first stage, broadcasters decide on commercial broadcasting time a in the second stage. In the third stage, viewers decide whether to watch one channel or the other.

Viewers differ in their preference for information content in relation to other content. A viewer of type λ prefers a fraction λ of news programs. Preferences are uniformly distributed between zero and one, that is, $\lambda \in [0, 1]$, and the utility that viewer λ derives from watching a channel is $u_1 = v - \tau(\lambda - d_1)^2 - \gamma \cdot a_1$ if he watches the first channel and $u_2 = v - \tau(\lambda - (1 - d_2))^2 - \gamma \cdot a_2$ if he watches the second channel. v is the utility a viewer derives if he watches a channel that broadcasts the program content he prefers and if there are no commercials ($a_1 = a_2 = 0$). It is assumed that the size of v is such that the market is always covered. In addition, the number of viewers is normalized to one. This means that the overall number of viewers is always equal to one and the number of viewers of a channel is equal to its market share. τ denotes the cost of watching a fraction of information broadcasting time not preferred by the viewer and γ is the nuisance cost for watching commercials. This is the model proposed by Peitz and Valletti (2008), although we rule out the possibility that viewers have to pay for watching TV.

The game is solved by backward induction. We assume that no viewer wants to switch channels to watch both channels for a fraction of time, but viewers prefer to stay with their preferred channel. In our example of news consumption, for a viewer who prefers a 30-minute overview of this weekend's soccer matches, it makes no sense to watch a five-minutes short report on one channel and 25 minutes of one of the weekend's matches on the other channel. He chooses the soccer broadcast that matches best his preferences for depth. Viewer $\hat{\lambda}$ who is indifferent between the channels is defined by

$$v - \tau(\hat{\lambda} - d_1)^2 - a_1\gamma = v - \tau(\hat{\lambda} - (1 - d_2))^2 - a_2\gamma \tag{1}$$

and equals

$$\hat{\lambda} = \frac{1 + d_1 - d_2}{2} - \frac{\gamma(a_1 - a_2)}{2(1 - d_1 - d_2)\tau}. \tag{2}$$

Without loss of generality, we number the channels such that $1 - d_2 \geq d_1$, so that the number of viewers of channel 1 is $n_1 = \hat{\lambda}$ and of channel 2 is $n_2 = 1 - \hat{\lambda}$.

Broadcasters generate profits exclusively from commercial revenues. We use the inverse advertising demand function per viewer proposed by Choi (2006), $p(a) = b \cdot a^{-\beta}$, where $b > 0$ is the scale parameter for advertising demand, which indicates the benefit from commercials for advertisers. $1/\beta$ with $0 < \beta < 1$ represents the constant price elasticity of advertising demand. This specification of advertising demand is a special case of the general function used by Peitz and Valletti (2008), but, as will become apparent, isoelastic advertiser demand facilitates the following analysis. We assume costs equal to zero as in Peitz and Valletti (2008); therefore the profit functions are

$$\Pi_i(d_i, d_j, a_i, a_j) = a_i \cdot p(a_i) \cdot n_i = b \cdot a_i^{1-\beta} \cdot n_i, \quad i, j \in \{1, 2\}. \tag{3}$$

Profits are maximized with respect to commercial broadcasting time, taking program choice as given. Solving

$$\frac{\partial \Pi_i(d_i, d_j, a_i, a_j)}{\partial a_i} = 0 \tag{4}$$

yields the profit-maximizing commercial broadcasting time for given program content,

$$a_1(d_1, d_2) = a_1^d = \frac{(1 - d_1 - d_2)(3 - 2\beta + d_1 - d_2)(1 - \beta)\tau}{(3 - 2\beta)\gamma} \tag{5}$$

and

$$a_2(d_1, d_2) = a_2^d = \frac{(1 - d_1 - d_2)(3 - 2\beta - d_1 + d_2)(1 - \beta)\tau}{(3 - 2\beta)\gamma}. \tag{6}$$

Taking the commercial broadcasting time in the second stage into account, broadcasters maximize their profits with respect to program content in the first stage for

$$\frac{d\Pi_i(d_i, d_j, a_i^d, a_j^d)}{d \quad d_i} = 0. \tag{7}$$

This yields a symmetric equilibrium for program content in the first stage:

$$d_i^* = \begin{cases} 0 & \text{if } 0 < \beta \le (2 - \sqrt{2})/2, \\ \beta - \frac{1}{2 \cdot (2 - \beta)} & \text{if } (2 - \sqrt{2})/2 < \beta < 1. \end{cases} \tag{8}$$

The commercial equilibrium broadcasting time in the second stage is

$$a_i^* = \begin{cases} (1 - \beta)\frac{\tau}{\gamma} & \text{if } 0 < \beta \le (2 - \sqrt{2})/2, \\ \frac{(1-\beta)^2(3-2\beta)}{(2-\beta)} \cdot \frac{\tau}{\gamma} & \text{if } (2 - \sqrt{2})/2 < \beta < 1 \end{cases} \tag{9}$$

and the indifferent viewer is $\lambda^* = 1/2$.

PROPOSITION 1: *In subgame perfect equilibrium, media channels never duplicate content for $\beta < 1$. Content differentiation decreases in β and reaches maximal differentiation for $\beta \le (2 - \sqrt{2})/2$. The optimal broadcasting time of commercials decreases in β and is positive for $\beta < 1$. If the elasticity of advertising demand is small, commercial broadcasting time is negligible (for $\beta \to 1$ we find $a^* \to 0$).*

The program content at equilibrium depends exclusively on the elasticity of advertising demand $1/\beta$, whereas in Peitz and Valletti (2008), equilibrium program content, in general, also depends on the nuisance cost γ and the disutility from content misspecification τ. The reason is that at the profit maximum, the reallocation tendency of channels depends on the elasticity of advertising demand (Proof see Appendix A). In the present model, the elasticity is constant. In the model used by Peitz and Valletti (2008), advertising demand is allowed to be isoelastic, but in general the elasticity of advertising demand changes as the number of commercials changes. The equilibrium number of commercials then depends on the nuisance cost γ and the disutility from content misspecification τ and therefore, so too does the equilibrium program content.

The outcome described is the market equilibrium without market interventions. To evaluate the welfare effects of a market intervention, we analyze the first-best welfare optimum below. Welfare comprises consumer benefit derived from watching TV, which is v, welfare with respect to content,

$$W^{co} = -\tau \cdot \left(\int_0^{\hat{\lambda}} (\lambda - d_1)^2 d\lambda + \int_{\hat{\lambda}}^1 (\lambda - (1 - d_2))^2 d\lambda \right), \tag{10}$$

which are welfare losses due to non-ideal content, and welfare with respect to advertising,

$$W^{ad} = n_1 \cdot \left(\int_0^{a_1} b \cdot a^{-\beta} da - \gamma \cdot a_1 \right) + n_2 \cdot \left(\int_0^{a_2} b \cdot a^{-\beta} da - \gamma \cdot a_2 \right), \tag{11}$$

which includes advertiser benefits derived from commercials and the nuisance cost for viewers. Since all viewers participate and λ is uniformly distributed, $d_i^{**} = 1/4$ is the welfare optimum with respect to content. For this content, losses for consumers, caused by the consumption of suboptimal programs, are minimized. With respect to commercials, $\partial W^{ad}/\partial a_1 = 0$ and $\partial W^{ad}/\partial a_2 = 0$ determine the optimum. With the assumption that the optimum is symmetric ($a_1 = a_2$), this is

$$\left. \frac{\partial W^{ad}}{\partial a_1} \right|_{a_1 = a_2} = \frac{1}{2} a_1 (1 + d_1 - d_2)(b - a_1^{\beta} \gamma) = 0 \tag{12}$$

and

$$\left. \frac{\partial W^{ad}}{\partial a_2} \right|_{a_1 = a_2} = \frac{1}{2} a_1 (1 + d_2 - d_1)(b - a_1^{\beta} \gamma) = 0. \tag{13}$$

This leads to the welfare-maximizing commercial broadcasting time

$$a_1^{**} = a_2^{**} = \left(\frac{b}{\gamma} \right)^{1/\beta} \tag{14}$$

and the indifferent viewer $\lambda^{**} = 1/2$.

LEMMA 1: *Let* $\hat{\beta} = \left(9 - \sqrt{17}\right)/8$ *and*

$$\hat{\tau} = \begin{cases} \gamma\,(b/\gamma)^{1/\beta}(1-\beta)^{-1} & \text{if } 0 < \beta \leq \frac{1}{2}(2-\sqrt{2}), \\ \gamma\,(b/\gamma)^{1/\beta}(2-\beta)(3-2\beta)^{-1}(1-\beta)^{-2} & \text{if } \frac{1}{2}(2-\sqrt{2}) < \beta < 1. \end{cases} \tag{15}$$

If $\beta = \hat{\beta}$*, there is no market failure with respect to content differentiation and if* $\tau = \hat{\tau}$*, there is no market failure with respect to commercial broadcasting time. Otherwise, at the subgame perfect equilibrium, content differentiation or commer-*

cial broadcasting time are not optimal:

		Content differentiation	
		$\beta < \hat{\beta}$	$\beta > \hat{\beta}$
Commercial	$\tau > \hat{\tau}$	*both excessive (I)*	*excessive/insufficient (II)*
broadcasting time	$\tau < \hat{\tau}$	*insufficient/excessive (III)*	*both insufficient (IV)*

To prove Lemma 1, $d_i^* \gtreqless d_i^{**}$ is solved for β and $a_i^* \gtreqless a_i^{**}$ for τ. Figure 1 gives an overview of the areas identified in Lemma 1.

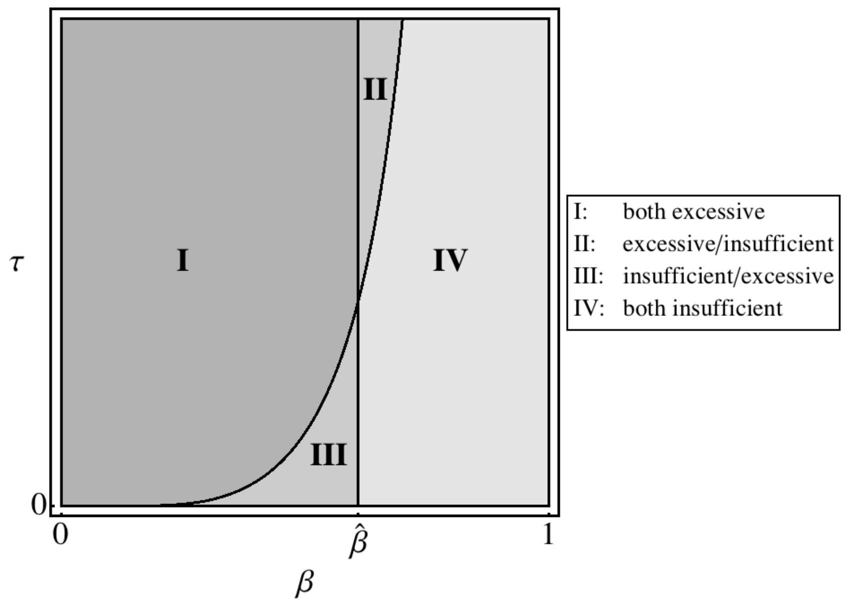

FIGURE 1. COMMERCIAL BROADCASTING TIME AND DIFFERENTIATION IN THE MARKET EQUILIBRIUM COMPARED TO THE FIRST-BEST CASE.

Depending on the elasticity of advertising demand ($1/\beta$), channel differentiation is either insufficient or excessive. The greater the elasticity of advertising demand (small β), the greater the channel differentiation (for $\beta \leq (2 - \sqrt{2})/2$, differentiation is even maximal, i.e. $d_i^* = 0$) and it becomes more likely that this differentiation will be excessive. Distortion with respect to commercial broadcasting time depends not only on β, but also on γ, τ and b. An increase in τ indicates a decrease in substitutability, which reduces competition between channels. Channels then increase the optimal fraction of commercials. Limited substitutability of channels from the perspective of viewers, that is, an increased level of market power for broadcasters (large τ), therefore also increases the propability that channels will broadcast more commercials than is socially efficient.[2]

To summarize, it is unlikely that the free market will simultaneously provide the welfare-optimizing commercial broadcasting time and the welfare-optimizing dif-

[2]Because there are two decision variables, which can either be insufficient or excessive at the market equilibrium compared to the social optimum, the result of the four possible cases of Lemma 1 are not restricted to the special revenue function for advertising used in the present model. However, by using a special form of advertising demand, we are able to precisely analyze all the four cases.

ferentiation of program content. A policy-maker can thus in many cases improve welfare through the regulation of commercial broadcasting time and of channel differentiation.

The European Audiovisual Media Services Directive aims at protecting viewers from excessive amounts of commercials and at improving content diversity. This indicates that the European regulators assume that the laissez-faire market is of Type *II*. This is in line with anecdotical evidence from viewers and print media who both complain about excessive commercials and content duplication in the TV market.

When it is almost impossible in practice to enforce certain program content restrictions, such as the depth of news, the implementation of commercial ceilings for regulating commercial broadcasting time is rather simple. Therefore, we focus on this instrument in the following section.

III. Commercial ceilings

In this section, we analyze commercial ceilings, assuming that a policy maker cannot restrict the content of channels directly. However, channels without content regulation react to a commercial ceiling by changing their program mix (Anderson, 2007).

Profits in the presence of a symmetric commercial ceiling $\bar{a}_1 = \bar{a}_2 = \bar{a}$ are

$$\Pi_1(d_1, d_2, \bar{a}) = b\ \bar{a}^{(1-\beta)} \frac{(1 + d_1 - d_2)}{2} \tag{16}$$

and

$$\Pi_2(d_1, d_2, \bar{a}) = b\ \bar{a}^{(1-\beta)} \frac{(1 + d_2 - d_1)}{2}. \tag{17}$$

Assuming the ceiling is a binding maximization with respect to d_1 and d_2 yields a symmetric equilibrium of

$$\bar{d_i} = \frac{1}{2}\left(1 - \frac{\bar{a}\ \gamma}{(1-\beta)\tau}\right) > d_i^*. \tag{18}$$

A regulator can introduce a commercial ceiling $\bar{a} < a_i^d$ to force broadcasters to reduce differentiation compared to the market equilibrium. The reaction of broadcasters to a commercial ceiling may even put a regulator in a position to induce channels to choose the first-best program differentiation (Anderson, 2007), but, because a regulator can not force broadcasters to choose more differentiation than the market equilibrium level, regulation cannot achieve the first-best program differentiation if program differentiation is insufficient at the market equilibrium. Furthermore, program content differentiation decreases as the commercial ceiling becomes stricter in the sense of lower. We can therefore formulate the following proposition.

PROPOSITION 2: *If direct content regulation is impossible, a regulator can use a commercial ceiling as substitute for content regulation, as long as he aims at implementing a content differentiation level that is lower than at the market equilibrium.*

However, without additional content regulation, which could be difficult to implement, a commercial ceiling can achieve a second-best outcome at most. This is because welfare with respect to commercials requires a different commercial ceiling than welfare with respect to content. Provided that the respective ceiling is binding, welfare with respect to commercials reaches its first-best value with a commercial ceiling of $\bar{a}^a$, whereas welfare with respect to content reaches its first-best value at $\bar{a}^d$ (Appendix B).

If the commercial ceiling that induces broadcasters to choose the first-best commercial broadcasting time does not coincide with the ceiling that induces them to choose the first-best program content differentiation, then a regulator cannot achieve a first-best outcome using a commercial ceiling. In fact, the first-best outcome can be achieved exclusively for $\tau = 2\gamma\,(b/\gamma)^{1/\beta}/(1-\beta) = \tau^{**} > \hat{\tau}$ (Appendix B).[3]

Therefore, we consider a second-best commercial ceiling $\bar{a}^s$ that maximizes overall welfare in the absence of program content regulation. To effectively induce broadcasters to choose a second-best optimum, the commercial ceiling must be binding, that is, $\bar{a}^s < a_i^*$. For such a ceiling, the following proposition holds.

PROPOSITION 3: *In the absence of program content regulation, commercial ceilings only increase welfare if disutility from content misspecification, τ, is sufficiently large. There is then a unique second-best commercial ceiling, $\bar{a}^s$, that maximizes overall welfare. The second-best commercial ceiling is between the first-best commercial broadcasting time with respect to advertising and the first-best commercial broadcasting time with respect to program content differentiation.*

Proof: See Appendix C.

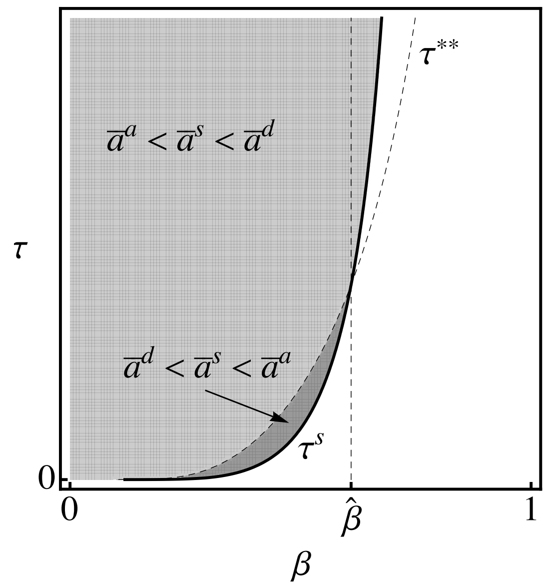

FIGURE 2. τ^s AND τ^{**} AND THE REGIONS FOR PROPOSITION 3.

[3]This implies that commercial broadcasting time, as well as program content differentiation, must be excessive in the market equilibrium.

Figure 2 illustrates this proposition. In the gray areas, τ is larger than τ^s, such that commercial ceilings may improve welfare, whereas a laissez faire approach is rational in the white areas. For a large β, there is not much content differentiation at the market equilibrium and therefore, not much time for commercial broadcasting. In this case, a further restriction on commercial broadcasting time causes channels to further reduce differentiation, which could decrease welfare with respect to content differentiation. Furthermore, it may not be optimal to restrict commercial broadcasting time if welfare with respect to advertising is considered.

A small disutility from content misspecification τ implies fierce competition between channels, preventing them from broadcasting a large number of commercials. A commercial ceiling may decrease welfare with respect to commercials in this case. Whether or not channel differentiation or commercial broadcasting time requires a commercial ceiling is reflected by τ^{**}. If $\tau > \tau^{**}$, excessive commercial broadcasting time requires a severe restriction, whereas a regulator would choose a looser restriction or no commercial ceiling with respect to program content differentiation ($\bar{a}^a < \bar{a}^d$). The light gray area in Figure 2 illustrates the parameter combinations for which a second-best commercial ceiling is less severe than a ceiling targeting excessive commercials only.

For $\tau < \tau^{**}$, excessive differentiation calls for a commercial ceiling, whereas the equilibrium commercial broadcasting time requires a looser or no restriction ($\bar{a}^a > \bar{a}^d$). The dark gray area in Figure 2 illustrates the parameter combinations for which a second-best commercial ceiling is stricter than a ceiling targeting excessive commercials only.

These findings provide insight into the efficiency of commercial ceilings.

COROLLARY 1: *If there is no content regulation, excessive broadcasting of commercials by channels is not a sufficient argument for the adoption of commercial ceilings.*

Although a commercial ceiling could restrict a broadcaster to the first-best commercial broadcasting time if it is excessive ($\bar{a}^a < a_i^*$), this is not the optimal policy if channel differentiation is insufficient ($a_i^* < \bar{a}^d$). In this case, $\bar{a}^a < a_i^* < \bar{a}^d$ holds and a commercial ceiling can increase overall welfare only if the second-best commercial ceiling is binding ($\bar{a}^s < a_i^*$). However, if $\bar{a}^a < a_i^* < \bar{a}^s < \bar{a}^d$ holds, the second-best commercial ceiling is not binding and any binding commercial ceiling decreases welfare compared to the market equilibrium. In this case, laissez faire, even though not welfare-maximizing, is the optimal policy.

Corollary 1 shows that the European Union's deregulation of commercial broadcasting can improve welfare even if the laissez-faire commercial broadcasting time is excessive. If, at the same time, laissez-faire content differentiation is insufficient (Area II in Figure 1) and competing channels are relatively good substitutes for viewers, τ is then rather small, laissez-faire is superior in terms of welfare to a policy that regulates commercials, but is unable to regulate differentiation.

It is well-known that if there are two-distortions (content and commercials) eliminating only one distortion (commercial ceilings) does not necessarily improve welfare (Lipsey and Lancaster, 1956). Corollary 1 shows that in the context of Free-to-air TV (with plausible assumptions), not regulating a distortion (excessive commercials) at all is the welfare maximizing policy.

COROLLARY 2: *If there is no content regulation, the insufficient broadcasting of commercials by channels is not a sufficient argument for banning commercial ceilings.*

If program content differentiation is excessive ($\bar{a}^d < a_i^*$), a binding second-best commercial ceiling ($\bar{a}^s < a_i^*$) can increase overall welfare, although commercial broadcasting time is insufficient ($a_i^* < \bar{a}^a$), because in this case, $\bar{a}^d < \bar{a}^s < a_i^* < \bar{a}^a$ holds. If the second-best commercial ceiling is not binding, every other binding commercial ceiling again decreases overall welfare compared to the market equilibrium.

To summarize, only if commercial broadcasting time and program content differentiation are both clearly excessive at the market equilibrium is a commercial ceiling able to increase overall welfare. If one is insufficient, the second-best commercial ceiling is between the first-best ceiling with respect to advertising and the first-best ceiling with respect to content, and the same holds for the market equilibrium commercial broadcasting time. Accounting for regulatory inefficiencies, it is unlikely that a commercial ceiling would increase overall welfare in these cases and the laissez-faire equilibrium appears to be the second-best outcome.

IV. Conclusion

Viewers of German private TV channels often complain about an overload of commercials. It is unlikely that an unregulated free-to-air TV market would provide efficient program content differentiation and the efficient number of commercials simultaneously. Regulation of both variables can improve welfare. However, the regulation of program content differentiation is hardly enforceable in practice. Commercial ceilings can stop excessive commercials, but in most circumstances, a regulator cannot reach a first-best outcome, because commercial broadcasting time and program content differentiation are interdependent. If laissez faire differentiation is not excessive, the benefit of decreased commercial broadcasting time may not compensate for a further decrease in program content differentiation caused by the commercial ceiling. The optimal (second-best) regulation of commercial broadcasting time of free-to-air TV channels has to take the side effect on content into account or is prone to fail. By deregulating the commercial communication, the EU is promoting the diversity of programmes in free-to-air TV.

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V. Mathematical Appendix

Appendix A

In a free-to-air market, advertising levels for symmetric program $d_1 = d_2 \leq 1/2$ satisfy

$$\rho'(a_i) = \frac{\rho(a_i)\gamma}{(1-2d_i)\tau}, \tag{19}$$

with $\rho = p(a_i)a_i$. The reallocation tendency of channels is

$$\frac{\partial \Pi_i}{\partial d_i} + \frac{\partial \Pi_i}{\partial a_j}\frac{\partial a_j}{\partial d_i} = N\rho(a_i)\left(\frac{\partial n_i}{\partial d_i} + \frac{\partial n_i}{\partial a_j}\frac{\partial a_j}{\partial d_i}\right), \tag{20}$$

so that the first-order condition for program content holds for

$$\frac{\partial n_i}{\partial d_i} + \frac{\partial n_i}{\partial a_j}\frac{\partial a_j}{\partial d_i} = 0. \tag{21}$$

With symmetric programs

$$\frac{1}{2} + \frac{\gamma}{2\tau(1-2d_i)}\left.\frac{\partial a_j}{\partial d_i}\right|_{d_i=d_j} = 0 \tag{22}$$

has to hold, because of equation 19 and equation 22 being equivalent to

$$\frac{a_j}{\epsilon_{\rho,a}} = - \left.\frac{\partial a_j}{\partial d_i}\right|_{d_i=d_j} \tag{23}$$

with $\epsilon_{\rho,a} = \rho' a_j/\rho$, the advertising elasticity of revenue, and $\epsilon_{\rho,a} = 1 - 1/\epsilon_{p,a}$ with $\epsilon_{p,a}$, the price elasticity of advertising demand.

In the present model as well

$$\epsilon_{\rho,a} = 1 - \beta \tag{24}$$

as

$$\left.\frac{\partial a_j}{\partial d_i}\right|_{d_i=d_j} / a_j = \frac{1}{2\beta - 3} + \frac{1}{2d_j - 1}, \tag{25}$$

depend on β, but not on τ or γ.

Appendix B

A commercial ceiling that induces broadcasters to broadcast the first-best commercial broadcasting time is calculated by maximizing welfare with respect to commercials:

$$W^{ad^a} = W^{ad}(\bar{a}, \bar{d}_i) = \int_0^{\bar{a}} b \cdot a^{-\beta} da - \gamma \cdot \bar{a} = \frac{b \cdot \bar{a}^{1-\beta}}{1-\beta} - \gamma \cdot \bar{a}. \tag{26}$$

Solving the first-order condition $\frac{\partial W^{ad^a}}{\partial \bar{a}} = 0$ yields the commercial ceiling that induces broadcasters to choose the first-best commercial broadcasting time

$$\bar{a}^a = a^{**} = \left(\frac{b}{\gamma}\right)^{1/\beta}. \tag{27}$$

The commercial ceiling that induces broadcasters to choose the first-best program content mix is calculated by maximizing welfare with respect to content:

$$\begin{aligned} W^{co^a} = W^{co}(\bar{a}, \bar{d}_i) &= -\tau \cdot \left(\int_0^{1/2} (\lambda - \bar{d}_1)^2 d\lambda + \int_{1/2}^{1} (\lambda - (1 - \bar{d}_2))^2 d\lambda \right) \\ &= \frac{1}{12} \left(\frac{3 \cdot \bar{a} \cdot \gamma}{1-\beta} - \frac{3 \cdot \bar{a}^2 \cdot \gamma^2}{(1-\beta)^2 \cdot \tau} - \tau \right). \end{aligned} \tag{28}$$

Solving the first-order condition $\partial W^{co^a}/\partial \bar{a} = 0$ yields the commercial ceiling that induces broadcasters to choose the first-best program content differentiation

$$\bar{a}^d = \frac{\tau(1-\beta)}{2\gamma}. \tag{29}$$

In order to demonstrate that this induces broadcasters to choose the first-best differentiation, we solve $a_1^d = a_2^d = \bar{a}^d$. This yields $\bar{d}^d = d_i^{**} = 1/4$. Commercial broadcasting time and program content differentiation reach their first-best values by the use of a commercial ceiling if $\bar{a}^a = \bar{a}^d$, which is fulfilled for

$$\tau^{**} = \frac{2\gamma\,(b/\gamma)^{1/\beta}}{1-\beta} \tag{30}$$

exclusively.

A commercial ceiling is only binding if $\bar{a} < a_i^* \Leftrightarrow \hat{\tau} < \tau$ holds. With respect to $\bar{a}^d$, the ceiling is binding for $\bar{d}^d < d_i^* \Leftrightarrow \hat{\beta} < \beta$.

$\tau = \tau^{**} > \hat{\tau}$ holds exclusively for $\beta < \hat{\beta}$.

Appendix C

We show that for $\tau > \tau^s$ with

$$\tau^s = \begin{cases} \frac{\gamma}{1-\beta}\left(\frac{4b(1-\beta)}{\gamma(5-4\beta)}\right)^{1/\beta} & \text{if } 0 < \beta \leq \frac{1}{2}(2-\sqrt{2}), \\ \frac{\gamma(2-\beta)}{(3-2\beta)(1-\beta)^2}\left(\frac{4b\left(\beta^2-3\beta+2\right)}{\gamma(8\beta^2-21\beta+12)}\right)^{1/\beta} & \text{if } \frac{1}{2}(2-\sqrt{2}) < \beta < 1 \end{cases} \tag{31}$$

there is a unique second-best commercial ceiling $\bar{a}^s$ that maximizes overall welfare W in the absence of program content regulation.

Overall welfare in the presence of a commercial ceiling $\bar{a}$ is

$$\begin{aligned} W(\bar{a},\bar{d}_i) &= W^{ad}(\bar{a},\bar{d}_i) + W^{co}(\bar{a},\bar{d}_i) \\ &= \frac{b\cdot\bar{a}^{1-\beta}}{1-\beta} - \gamma\cdot\bar{a} + \frac{1}{12}\left(\frac{3\cdot\bar{a}\cdot\gamma}{1-\beta} - \frac{3\cdot\bar{a}^2\cdot\gamma^2}{(1-\beta)^2\cdot\tau} - \tau\right) \end{aligned} \tag{32}$$

with

$$\frac{\partial W}{\partial \bar{a}} = b\bar{a}^{-\beta} - \frac{\gamma(2\bar{a}\gamma + (1-\beta)(3-4\beta)\tau)}{4(1-\beta)^2\tau}. \tag{33}$$

Because

$$\lim_{\bar{a}\to 0}\frac{\partial W}{\partial \bar{a}} = \infty, \tag{34}$$

$$\lim_{\bar{a}\to \infty}\frac{\partial W}{\partial \bar{a}} = -\infty \tag{35}$$

and

$$\frac{\partial^2 W}{\partial \bar{a}^2} = -b\beta\bar{a}^{-\beta-1} - \frac{\gamma^2}{2(1-\beta)^2\tau} < 0 \tag{36}$$

for all $\bar{a} > 0$, there is a unique $\bar{a}^s$ with

(37) $$\frac{\partial W}{\partial \bar{a}} \gtreqless 0 \Longleftrightarrow \bar{a} \lesseqgtr \bar{a}^s.$$

Simple calculation shows that

(38) $$\left.\frac{\partial W}{\partial \bar{a}}\right|_{\bar{a}=\bar{a}^a} = \gamma - \frac{\gamma\left(2\left(\frac{b}{\gamma}\right)^{\frac{1}{\beta}}\gamma + (-1+\beta)(-3+4\beta)\tau\right)}{4(-1+\beta)^2\tau} \lesseqgtr 0 \Longleftrightarrow \tau \lesseqgtr \tau^{**}$$

and

(39) $$\left.\frac{\partial W}{\partial \bar{a}}\right|_{\bar{a}=\bar{a}^d} = -\gamma + 2^\beta b\left(\frac{\tau - \beta\tau}{\gamma}\right)^{-\beta} \gtreqless 0 \Longleftrightarrow \tau \lesseqgtr \tau^{**},$$

which can be summarized as

(40) $$\left.\frac{\partial W}{\partial \bar{a}}\right|_{\bar{a}=\bar{a}^a} \lesseqgtr 0 \text{ and } \left.\frac{\partial W}{\partial \bar{a}}\right|_{\bar{a}=\bar{a}^d} \gtreqless 0 \Longleftrightarrow \tau \lesseqgtr \tau^{**}.$$

Combining (37) and (40) results in

(41) $$\bar{a}^d < \bar{a}^s < \bar{a}^a \text{ iff } \tau < \tau^{**} \text{ and } \bar{a}^a < \bar{a}^s < \bar{a}^d \text{ iff } \tau > \tau^{**}.$$

For $\tau = \tau^{**}$, the second-best commercial ceiling is in fact the first-best commercial ceiling.

To effectively induce broadcasters to choose the second-best outcome, $\bar{a}^s < a_i^*$ must hold. This is true if and only if

(42)
$$\left.\frac{\partial W}{\partial \bar{a}}\right|_{\bar{a}=a_i^*} = \begin{cases} -\frac{(5-4\beta)\gamma}{4(1-\beta)} + b\left(\frac{(1-\beta)\tau}{\gamma}\right)^{-\beta} & \text{if } 0 < \beta \leq \frac{1}{2}(2-\sqrt{2}) \\ -\frac{(12-(21-8\beta)\beta)\gamma}{4(1-\beta)(2-\beta)} + b\left(\frac{(1-\beta)^2(3-2\beta)\tau}{(2-\beta)\gamma}\right)^{-\beta} & \text{if } \frac{1}{2}(2-\sqrt{2}) < \beta < 1 \end{cases}$$

is negative, which holds for $\tau > \tau^s$ with

(43) $$\tau^s = \begin{cases} \frac{\gamma}{1-\beta}\left(\frac{4b(1-\beta)}{\gamma(5-4\beta)}\right)^{1/\beta} & \text{if } 0 < \beta \leq \frac{1}{2}(2-\sqrt{2}), \\ \frac{\gamma(2-\beta)}{(3-2\beta)(1-\beta)^2}\left(\frac{4b\left(\beta^2-3\beta+2\right)}{\gamma(8\beta^2-21\beta+12)}\right)^{1/\beta} & \text{if } \frac{1}{2}(2-\sqrt{2}) < \beta < 1. \end{cases}$$

□

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