

Thöne, Miriam; Rasch, Alexander; Wenzel, Tobias

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Business models in commercial media markets: Bargaining, advertising, and mixing

Alexander Rasch^{1,*} Miriam Thöne^{1,†}
Tobias Wenzel^{1,2,‡}

¹Düsseldorf Institute for Competition Economics (DICE), Universität Düsseldorf

²University of Bath

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Abstract

We consider a product and a media market and show how a change in the business model employed by the media platforms affects consumers, producers (or advertisers), and price negotiations for advertisements. On both markets, two firms differentiated à la Hotelling compete for consumers. On the media market, consumers can mix between the two outlets whereas on the product market, consumers have to decide for one supplier. With pay-tv, as opposed to free-to-air, mixing by consumers disappears, product prices and advertising rates increase while the number of advertisements declines and media firms' profits increase. These effects are driven by the improved bargaining position of media firms, induced by charging a subscription fee to viewers.

Keywords: Media Competition; Two-Sided Markets; Business Strategy; Mixing.

JEL Classification Numbers: L10, D21.

*Düsseldorf Institute for Competition Economics (DICE), Heinrich Heine University Düsseldorf, Universitätsstr. 1, 40225, Düsseldorf, Germany. (E-mail: rasch@dice.hhu.de)

†Düsseldorf Institute for Competition Economics (DICE), Heinrich Heine University Düsseldorf, Universitätsstr. 1, 40225, Düsseldorf, Germany. (E-mail: thoene@dice.hhu.de)

‡University of Bath, Department of Economics, Claverton Down, Bath, BA2 7AY, United Kingdom. (E-mail: t.wenzel@bath.ac.uk).

1 Introduction

In many countries, the tv market is heavily polarized between free-to-air businesses (where revenues come from advertisements only) and pay-tv businesses (where revenues come from both advertisements and subscriptions). Until a few years ago, selling advertising space was the dominant form of financing among media platforms in the tv sector; nowadays it is closely followed by pay-tv. In 1970, less than 7% of the households in the US were subscribers to pay-tv channels, but since then this number has risen steadily up to 87% in 2010.¹ In contrast to this, there are also examples of channels which decided to switch from pay-tv to free-to-air. In 2014, three French subscription channels (TF1, M6, and Canal+) applied to France's broadcast regulator to become fully ad-supported.² In the same vein, the following year PBS America, the UK arm of the US public broadcaster, lifted its encryption and went free-to-air.³ This indicates that not only do different forms of financing exist in the tv market but there is also a substantial amount of switching between business models.

In this paper, we investigate the implications of switching from free-to-air to pay-tv for both media and product markets and derive conditions under which one business model is more profitable for platforms than the other. In addition we evaluate each business model in terms of its impact on consumer behavior and total welfare. To do so, we build on the theoretical models developed in Dukes and Gal-Or (2003) and Gal-Or and Dukes (2003). In those papers, both the product and the media market are modeled à la Hotelling and media firms bargain with producers over the price for advertising space. Advertising is informative and a higher number of advertising messages raises the likelihood of a consumer becoming informed about the advertised product, but also increases competition on the product market. In addition to this, viewers can split their time between the two platforms on the media market but can only buy from one of the producers on the product market. Analyzing the choice of business model in this setting has the advantage that we can identify the effects on advertising prices and determine the repercussions on the product market and consumer choice when a switch in the business model occurs.

Our paper makes two important contributions. First, we analyze the effect of different business

¹See Waterman *et al.* (2012).

²See <http://uk.reuters.com/article/us-france-television-idUKKBN0FY1FG20140729>.

³See <http://www.digitalteveurope.net/440051/pbs-america-to-go-free-to-air-in-the-uk/>.

models in a setting where advertising rates are determined via a bargaining process. This yields important insights with respect to platform profits and advertising rates. We find that, as opposed to free-to-air, with pay-tv platforms have a higher negotiating leverage vis-à-vis the producers which causes an increase in advertising rates and higher platform profits. Second, we explicitly model the product market which allows us to make clear statements about how the business model choice affects competition and consumer welfare on the product market. In case of pay-tv, the increased advertising rates result in softer price competition and a lower consumer surplus on the product market as compared to free-to-air. Considering both markets, consumers are always worse off as the change in business model also affects their mixing behavior on the media market. With pay-tv consumers do not mix, while with free-to-air all of them choose their preferred content mix. As mixing across channels allows consumer to view their preferred content, introducing pay-tv reduces consumer surplus. Total welfare may be higher or lower. This result is in contrast to models analyzing similar questions while pursuing a different modeling approach who have mostly emphasized the benefits of subscription services. In our model only platforms always gain from switching to pay-tv. Overall, our paper contributes to the understanding of the effect a switch in business model has on the respective media market, its viewers, producers, and the number of advertisements.

Our findings could explain the steady migration from free-to-air to subscription services in the tv sector in the past decades. However, this trend may not be beneficial for consumers and under certain circumstances may even lead to a deterioration of total welfare. Our findings further improve our understanding of the market mechanism in the tv sector and can help guide regulative authorities in determining the effect of channels switching business model as in the case of France.

The rest of the paper is organized as follows. Section 2 relates our work to the relevant literature. Section 3 describes the model. In sections 4 and 5, the symmetric equilibria with free-to-air and pay-tv competition are derived, which is followed by a comparison of the results and their implications for consumer surplus and total welfare. Section 6 concludes.

2 Related literature

Our paper is generally related to the growing literature on two-sided markets but more closely to the economics of media markets (see Anderson and Gabszewicz (2006) for a survey). Starting with the seminal work by Anderson and Coate (2005) who determine conditions under which advertising is either under- or overprovided as compared to the social optimum, important insights could be gained from the literature that followed. In many cases, the media market was analyzed assuming that consumers choose only one platform while advertisers are able to advertise on all platforms creating a competitive bottleneck (Armstrong, 2006). However, particularly when it comes to watching television viewers can divide their time between several channels and platforms not only need to compete for advertisers but also for consumers (Gabszewicz *et al.*, 2004). In addition, some of the literature on media markets has solely focused on free-to-air competition between media platforms (Kind *et al.*, 2007; Reisinger *et al.*, 2009; Reisinger, 2012), while others have analyzed media markets with subscription fees (Prasad *et al.*, 2003; Reisinger, 2014) or a pay-per-view pricing strategy (Godes *et al.*, 2009).

Our modelling approach builds on the models in Dukes and Gal-Or (2003) and Gal-Or and Dukes (2003) and shares the main ingredients of bargaining between advertisers and media platforms, mixing on the viewer side, and the implications for product market competition. Both their papers focus on free-to-air competition. In their model, Dukes and Gal-Or (2003) investigate the effect of exclusive contracts between media platforms and advertisers on advertisements, consumers, and product market competition. They show that exclusive contracts lead to fewer informed consumers and less competition among advertisers. In Gal-Or and Dukes (2003), the same authors demonstrate that with endogenous location choice by media platforms, differentiation among them is minimal with free-to-air. Unlike their contributions, we evaluate the effects of different business models in a similar environment. By contrast, we neither consider location choice nor exclusive contracts in our setup. A platform's location is exogenous such that content is maximally differentiated on both product and media market and negotiations always take place between each media firms and advertisers. This makes the model more tractable and it is easier to identify the effects of a change in business model by the platforms on the relevant variables.

Few papers have addressed the topic of business model choice in media markets. For example,

Peitz and Valletti (2008) analyze a tv market with consumers who do not mix between channels and multi-homing advertisers with the aim to compare content choice and advertising decisions between the two business models. They find that neither pay-tv nor free-to-air lead to socially optimal outcomes as market failures arise in response to a misalignment of incentives between competing platforms and society. As a result, they find an underprovision of advertising with pay-tv competition as compared to the social optimum and a tendency to advertise more with free-to-air under the assumption that content is sufficiently differentiated. Endogenizing the location choice leads to less differentiation with free-to-air than with pay-tv which is socially preferable. While the model by Peitz and Valletti (2008) is similar to ours, in our model also consumers are able to mix and we show that the choice of business model by the platform influences their mixing decision. Furthermore, in our model we do not focus on the question of content but rather on how the business model affects the bargaining mechanism between platforms and advertisers and thereby advertising prices.

Kind *et al.* (2009) study the effect different forms of competition have on business model choice. In their model, platforms can either choose to be either solely supported by advertising, direct payments from viewers, or a combination of both. Here, advertisers and consumers are both able to mix between platforms. Kind *et al.* (2009) find that a higher substitutability between media platforms makes platforms more dependent on advertising revenues, while a higher number of competitors on the media market has the opposite effect. By comparison, our model does not consider different forms of competition. Instead we focus on the case where both on the product and the media market there are two suppliers and on both markets firms are maximally differentiated. This allows us to identify the effects of a change in business model on producers, consumers, and platforms. In contrast to their approach, we also examine how business model choice affects the bargaining power of platforms vis-à-vis producers.

Choi (2006) examines the implication of different business models in a setting where entry into the market is endogenous. Unlike our paper with a fixed number of media platforms, the product market is not explicitly modeled and there is no bargaining over rates between producers and media platforms. Media consumers are single-homing. In this setting, the author shows that with pay-tv there is insufficient advertising and excessive entry into the media market. With free-to-air the results are more ambiguous and excessive as well insufficient advertising levels may occur.

To the best of our knowledge, we are the first to analyze the effect of different business models in the context of media markets when the product market is characterized by a duopoly instead of perfect competition and platforms bargain over advertising prices with producers.

3 The model

There are two markets: the media market and the product market. Two platforms $j = 1, 2$ are active on the media market.⁴ The media platforms earn revenues from selling advertising space and potentially charging viewers. On the product market, two producers (or advertisers) $i = A, B$ are competing for consumers by advertising their products on either or both of the platforms. Each market is modeled via a Hotelling unit line where platforms and producers are differentiated maximally (Hotelling, 1929). Platforms are competing for both advertisers and a unit mass of homogeneous consumers. Consumers are uniformly located between 0 and 1 on both markets. Preferences for platforms are distributed independently from those for producers.

3.1 Media market

Each consumer can decide whether she wants to allocate all her time to one of the platforms or divide it between them, i.e., she can mix (Anderson and Neven, 1989). The distance of a consumer on the media market to platform 1 is denoted by x and the time a consumer at location x allocates to platform 1 is designated by $\lambda(x)$. In turn, with total time normalized to one, $1 - \lambda(x)$ is the time a consumer at location x allocates to platform 2.

A consumer of type x who allocates her time to both platforms derives a net utility of $v_s - t_s[1 - \lambda(x) - x]^2 - \kappa_1 - \kappa_2$. The closer a consumer's allocation of time to her preferred program mix reflected by her type x , the smaller the disutility she incurs. A consumer who chooses a mix of programs which perfectly matches her preferences derives utility v_s and does not incur any disutility. We assume that viewers' disutility from not consuming their preferred programming content is quadratic, where t_s denotes the disutility parameter which measures the degree of differentiation between the two platforms. Platforms charge a subscription fee $\kappa_j \geq 0$ to consumers.

⁴The model is described in a television context, but it also applies to other media outlets, like the Internet, radio, or magazines.

3.2 Advertisers and advertising technology

In our model, advertising is informative (Grossman and Shapiro, 1984). Producers can inform consumers about their product by sending advertising messages φ_i^j via each of the platforms. The probability that a given producer informs a consumer on a given platform, i.e., the outreach probability, is $G(\varphi_i^j)$. It increases in the number of advertisements at a decreasing rate such that $G(0) = 0$, $G'(\cdot) > 0$, and $G''(\cdot) < 0$.⁵ The higher the number of advertising messages, the better the chances that she will make a purchase on the product market. Furthermore, to ensure that producers choose positive levels of advertising and that its net marginal contribution is positive, we define

$$T(\varphi) \equiv \frac{G'(\varphi)}{G(\varphi)} - \frac{1}{2\varphi}, \quad (1)$$

where $T(\varphi) > 0$ and $T'(\varphi) < 0$.

Consumers buy at most one unit of the product. A consumer who has only seen the advertisement of one of the producers will buy the advertised product, unaware of the competing producer's offer and regardless of her location.⁶ A consumer who has not seen any advertisements refrains from making a purchase on the product market. Consumers who have seen advertising messages from both producers can decide whether to buy from producer A or producer B .⁷

The distance of a consumer to producer A is denoted by y . A consumer located at y derives a net utility of $v_p - t_p y^2 - p_A$ when purchasing the product of producer A and $v_p - t_p (1-y)^2 - p_B$ when purchasing from producer B , where t_p is the differentiation parameter for the product market. The price charged by producer i is denoted by p_i .

3.3 Consumer demand

Given the advertisements φ_i^j on either of the platforms by the producers and the subscription fees κ_1 and κ_2 , a consumer with preferences of x derives the following utility from consuming media

⁵These assumptions are sufficient to guarantee the existence of an interior solution to the producers' maximization problem in sections 3.1 and 4.2. A proof can be found in Gal-Or and Dukes (2003, p. 317-318).

⁶We assume that the product market is fully covered, i.e., a consumer will always make a purchase as long as she knows about at least one of the products.

⁷We assume that mixing is not possible on the product market.

products:

$$U(x) = v_s - t_s \{1 - \lambda(x) - x\}^2 - \gamma \{ \lambda(x)(\varphi_A^1 + \varphi_B^1) + [1 - \lambda(x)](\varphi_A^2 + \varphi_B^2) \} - \kappa_1 - \kappa_2, \quad (2)$$

where $\gamma > 0$ is a nuisance parameter which captures consumers' dislike for commercial interruptions. On the media market, consumers can choose their favorite programming mix but still incur a utility loss due to advertisements. The disutility parameter from not consuming the ideal media content is t_s .

Consumers decide on the optimal amount of time they want to spend on platform 1 by maximizing (2) with respect to $\lambda(x)$. This results in the allocation rule and platforms' market shares summarized in Lemma 1.⁸

Lemma 1 *Viewers allocate their time according to the following allocation rule:*

$$\lambda(x) = \begin{cases} 1 & \text{if } x \leq \sqrt{\frac{\kappa_2}{t_s}} - R, \\ 1 - x - R & \text{if } \sqrt{\frac{\kappa_2}{t_s}} - R < x \leq 1 - \sqrt{\frac{\kappa_1}{t_s}} - R, \\ 0 & \text{otherwise,} \end{cases} \quad (3)$$

where $R \equiv \frac{\gamma[(\varphi_A^1 + \varphi_B^1) - (\varphi_A^2 + \varphi_B^2)]}{2t_s}$.

As long as advertising levels and subscription fees do not differ too much between platforms, this allocation rule results in the following market shares for each of the outlets⁹:

$$X^1 = \frac{1}{2} - R - \frac{(\kappa_1 - \kappa_2)}{2t_s} \quad \text{and} \quad X^2 = \frac{1}{2} + R + \frac{(\kappa_1 - \kappa_2)}{2t_s}. \quad (4)$$

Consumers with less extreme preferences, i.e., those located between $\sqrt{\frac{\kappa_2}{t_s}} - R$ and $1 - \sqrt{\frac{\kappa_1}{t_s}} - R$ are subscribers to both platforms. Within this interval, consumers who are located closer to platform 1, spend most of their time viewing platform 1 but less so with increasing proximity to platform 2. Those consumers with a very strong preferences for one of the two media platforms, i.e., consumers located outside the interval, prefer to subscribe exclusively to the platform closest

⁸The proof of this lemma, as well as of all other lemmas and propositions is included in the Appendix.

⁹The restriction concerning advertising levels and subscription fees does not affect our results as throughout the paper we focus on those cases in which producers and platforms behave symmetrically.

to them. An increase in the subscription fee by one of the platforms causes a shift in viewer shares. The number of exclusive subscribers to the rival outlet increases while the total amount of consumers mixing between the two outlets declines. By the same token, an increase in the advertising intensity by one platform increases the market share of its competitor. Contrary to higher subscription fees, this increase is only driven by a shift in exclusive subscribers, the amount of viewers that mix between both outlets remains unchanged.

The optimal viewing time $\lambda(x)$ a consumer allocates to platform 1 determines how likely she is to be informed by the advertisement of each of the producers. The probability that producer i informs a consumer about his product when advertising it on both platforms is $\lambda(x)G(\varphi_i^1) + (1 - \lambda(x))G(\varphi_i^2)$. The expected share of consumers an advertiser reaches via messages on both platforms is $X^1G(\varphi_i^1) + X^2G(\varphi_i^2)$. Now we can define the demand for producer i 's product, i.e., the probability that a viewer is not only aware of but also purchases i 's product:

$$D_i^j = \left[[1 - G(\varphi_k^j)] + G(\varphi_k^j) \left(\frac{1}{2} + \frac{p_k - p_i}{2t_p} \right) \right] G(\varphi_i^j), \quad i \neq k; \quad i = A, B. \quad (5)$$

A consumer who only sees producer i 's advertisement but not his rival's advertisement will purchase his product for sure. A consumer's purchase decision after having seen both advertisements depends on product prices and her type. The expected market share on a given platform for producer i is then the probability D_i^j that a consumer purchases from i multiplied with the share of consumers X^j the platform entertains. This results in the following total market share for producer i : $MS_i = X^1D_i^1 + X^2D_i^2$.

3.4 Payoffs and bargaining

The payment for advertising is a linear function of the number of advertising messages, assuming that platforms and producers cannot engage in long-term contracting. If producer i chooses to advertise amount φ_i^j on platform j , his payment to the platform is $a_i^j \varphi_i^j$, where a_i^j is the rate paid per advertising message. Payments are determined in pairwise negotiations between platforms and producers which are modeled using the Nash bargaining solution. The bargaining process between each platform-producer pair happens simultaneously and neither one can observe the outcome of their competitors negotiations before signing the advertising agreement. The bargaining process is

modeled à la Nash and the gains from an agreement are split equally among the two negotiating parties.¹⁰ Here, the gain from a successful negotiation is defined as the sum of the differences between each parties' agreement and disagreement payoffs. After successful negotiations, half of this gain will then go to the platform, the other half to the producer.

A platform's payoff C_j is equal to its revenue from selling advertising space to producers and subscriptions to consumers less a fixed operating cost of f . The profit of a platform j is therefore

$$C_j = a_A^j \varphi_A^j + a_B^j \varphi_B^j + R_j \kappa_j - f \quad j = 1, 2, \quad (6)$$

where $R_1 \equiv 1 - \sqrt{\frac{\kappa_1}{t_s}} - R$ and $R_2 \equiv 1 - \sqrt{\frac{\kappa_2}{t_s}} + R$, and R_j denotes the share of subscribers to platform j .

For production each producer incurs a fixed cost of k and a variable cost of c . A producer's payoff F_i then consists of the profit made from selling his product to consumers less the cost for advertising. A producer's payoffs is

$$F_i = (p_i - c)(X^1 D_i^1 + X^2 D_i^2) - (a_i^1 \varphi_i^1 + a_i^2 \varphi_i^2) - k, \quad i = A, B. \quad (7)$$

To determine the gains from an agreement, the payoffs in case of disagreement need to be specified. As we focus on equilibria where both producers advertise on both platforms, in this model disagreement implies that if negotiations between one platform-producer pair break down the same platform still comes to an agreement with the respective other producer and the producer still comes to an agreement with the respective other platform. Disagreement payoffs are:

$$C_j^{-i} = a_l^j \varphi_l^j + \left(R_j + \frac{\gamma \varphi_i^j}{2t_s} \right) \kappa_j - f, \quad (8)$$

$$F_i^{-j} = \tilde{X}^r D_i^r (p_i - c) - a_i^r \varphi_i^r - k, \quad i \neq l; j \neq r; j = 1, 2; i = A, B$$

where $\tilde{X}^r = \frac{1}{2} - \frac{\gamma(\varphi_A^r + \varphi_B^r - \varphi_i^j)}{2t_s} - \frac{\kappa_2 - \kappa_1}{2t_s}$. The effect of a disagreement between one platform-producer pair on the platform's payoffs is twofold. On the one hand, the payoff is reduced as advertising income now consists of payments by only one producer. On the other hand, the platform's program

¹⁰The model can straightforwardly be extended to asymmetric Nash bargaining where the bargaining power of the parties differs. However, as the results do not change qualitatively we consider the case with equal bargaining power.

now features fewer commercials as compared to its rival. This, in turn, attracts more consumers and subscription revenues increase. For producers, disagreeing with one of the platforms results in lower advertising costs and fewer product sales. The latter is a direct consequence of the change in platform market shares and a lower outreach probability. The platform with which bargaining was successful loses viewers to its rival who only shows commercials by one of the producers. As a result, commercials by the disagreeing producer reach fewer consumers.

3.5 Timing

The game consists of two stages. In the first stage payment negotiations between platforms and producers take place, producers choose the optimal amount of advertising messages to be broadcasted on each platform and decide on product prices. Advertising rates and advertising intensities are determined simultaneously. This implies that all negotiations take place at the same time and producers cannot observe the bargaining outcome of their rival. The same holds true for platforms. In the second stage consumers choose how much time to devote to either platform and make a purchase on the product market, contingent on their information on products available.

4 Free-To-Air

In this section we briefly review the results of Gal-Or and Dukes (2003), i.e., we derive the equilibrium results for our model under the assumption that there is competition between two free-to-air platforms. These serve as a benchmark for a later comparison with a second business model, where platforms also receive direct payments from viewers (pay-tv).

4.1 Bargaining

Under free-to-air each platform has only one source of income, namely advertising revenues, and contents of the media channels are provided to consumers for free. In the model setup presented in the previous sections this is the case when $\kappa_j = 0$. The payoffs for platforms and producers in

case of agreement and disagreement are then:

$$\begin{aligned}
C_j &= a_A^j \varphi_A^j + a_B^j \varphi_B^j - f, \\
F_i &= (p_i - c)(X^1 D_i^1 + X^2 D_i^2) - (a_i^1 \varphi_i^1 + a_i^2 \varphi_i^2) - k, \\
C_j^{-i} &= a_l^j \varphi_l^j - f, \\
F_i^{-j} &= \tilde{X}^r D_i^r (p_i - c) - a_i^r \varphi_i^r - k, \quad i \neq l; \quad j \neq r; \quad j = 1, 2; \quad i = A, B.
\end{aligned} \tag{9}$$

The Nash bargaining solution maximizes the product of the gains from a bargaining agreement of both parties over the negotiated advertising rate a_i^j . This results in an even split of the bargaining gains among both parties, such that $C_j - C_j^{-i} = F_i - F_i^{-j}$ and therefore advertising revenues are

$$a_i^j \varphi_i^j = \frac{p_i - c}{2} \left(X^j D_i^j + \frac{\gamma \varphi_i^j D_i^r}{2t_s} \right). \tag{10}$$

The first term on the left of the bracketed equation multiplied by $p_i - c$ is the gain from producer i 's sales induced by advertising on platform j . The term on the right multiplied by $p_i - c$ represents a premium paid to platform j for the forgone product sales to consumers who would have chosen to subscribe to platform j if producer i had not advertised on it. Lowering the advertising intensity φ_i^j affects both components of the Nash bargaining solution. On the one hand profits from product sales increase due to the diminished competition on the product market induced by fewer informed consumers. On the other hand, part of the premium decreases as the impact of disagreement between a platform-producer pair on viewers is now smaller since there are fewer advertisements to begin with.

4.2 The symmetric equilibrium

Producers maximize their payoffs with respect to product prices p_i and the amount of advertising messages φ_i^j while taking the negotiated advertising rate a_i^j as given:

$$\begin{aligned}\frac{\partial F_i}{\partial \varphi_i^j} &= (p_i - c) \left(X^j D_i^j \frac{G'(\varphi_i^j)}{G(\varphi_i^j)} - \frac{\gamma(D_i^j - D_i^r)}{2t_s} \right) - a_i^j = 0, \\ \frac{\partial F_i}{\partial p_i} &= (X^j D_i^j + X^r D_i^r) + (p_i - c) \left(X^j \frac{\partial D_i^j}{\partial p_i} + X^r \frac{\partial D_i^r}{\partial p_i} \right) = 0,\end{aligned}\tag{11}$$

$$r \neq j; \quad j = 1, 2; \quad i = A, B.$$

Since producers are identical in their payoffs and symmetric in their locations on the Hotelling line, we set our focus on symmetric equilibria. This implies that producers choose the same level of advertising across stations $\varphi_A^j = \varphi_B^j = \varphi^j$, the same prices for their products $p_A = p_B = p$ and are charged identical rates for advertising by a given platform $a_A^j = a_B^j = a^j$. Using the result from the Nash bargaining solution in equation (10) and taking the symmetry of producers into account yields the first-order conditions in (12)

$$\begin{aligned}\left. \frac{\partial F_i}{\partial \varphi_i^j} \right|_{Sym} &= (p - c) \left(X^j D^j \left[\frac{G'(\varphi^j)}{G(\varphi^j)} - \frac{1}{2\varphi^j} \right] - \frac{\gamma(2D^j - D^r)}{4t_s} \right) = 0, \\ \left. \frac{\partial F_i}{\partial p_i} \right|_{Sym} &= (X^j D^j + X^r D^r) - (p - c) \left(X^j \frac{G(\varphi^j)^2}{2t_p} + X^r \frac{G(\varphi^r)^2}{2t_p} \right) = 0,\end{aligned}\tag{12}$$

where $X^1 \equiv \frac{1}{2} - \frac{\gamma(2\varphi^1 - 2\varphi^2)}{2t_s}$, $X^2 \equiv 1 - X^1$ and $D^j \equiv D_1^j = D_2^j = \frac{1}{2}[2 - G(\varphi^j)]G(\varphi^j)$.

Note that as $T(\varphi) > 0$ ensures a positive level of advertising. If that assumption were violated then producers would prefer not to advertise on either platform in the symmetric equilibrium.¹¹ The symmetric equilibrium can now be fully characterized. To facilitate a later comparison between the two business models, the equilibrium results under free-to-air are indexed by "F".

Producers choose the following amount of advertising in equilibrium

$$\varphi_F^* = T^{-1} \left(\frac{\gamma}{2t_s} \right).\tag{13}$$

¹¹Note also that as $T'(\varphi) > 0$ it is ensured that reactions functions are stable. See Gal-Or and Dukes (2003, p. 318–320) for the details.

Equilibrium product prices are

$$p_F^* - c = \frac{t_p[2 - G(\varphi_F^*)]}{G(\varphi_F^*)}. \quad (14)$$

This results in the following payoffs for both platforms and producers in the symmetric equilibrium:

$$C_F^* = \frac{t_p[2 - G(\varphi_F^*)]^2}{4} \left(1 + \frac{\gamma\varphi_F^*}{t_s} \right) - f, \quad (15)$$

$$F_F^* = \frac{t_p[2 - G(\varphi_F^*)]^2}{4} \left(1 - \frac{\gamma\varphi_F^*}{t_s} \right) - k.$$

Both components of the Nash bargaining solution appear in the symmetric equilibrium profits of platforms and producers. The first part of both profit functions corresponds to the profits each advertiser makes on the product market in equilibrium and which are shared in equal parts in the bargaining process. The second part, which is equivalent to a transfer from producers to platforms is the equilibrium premium paid, in order to compensate platforms for the forgone viewers. A lower equilibrium advertising intensity φ_F^* has the same effect on profits as it does on the bargaining outcome. Advertisers enjoy higher profit margins, as the price p_F^* rises, while part of the premium to be paid to platforms decreases.

The number of advertising messages chosen in equilibrium increases as disutility from not viewing the preferred media content grows. It decreases when the nuisance parameter is high, i.e., producers advertise less aggressively when consumers' dislike of commercial interruptions is high. The prices decrease in the outreach probability $G(\varphi_F^*)$ and hence in the amount of advertisements but increase in the differentiation parameter on the product market.

Also note that in the symmetric equilibrium, consumers are mixing and hence they are able to choose a combination of programs which exactly satisfies their tastes. Formally, this means that in equilibrium $R^* = 0$. As a result, no consumer incurs any disutility cost from consuming media products and a consumer's utility located at x is: $U(x) = v_s - \gamma\{(1-x)(\varphi_A^1 + \varphi_B^1) + x(\varphi_A^2 + \varphi_B^2)\}$. As compared to a case where only some consumers mix or consumers do not mix at all between platforms, viewers are better off here because none of them have to bear disutility costs.

5 Pay-TV

In this section we analyze the equilibrium under competition between two pay-tv platforms. With pay-tv, platforms have two sources of income: the revenues from selling advertising space to producers and revenues from selling subscriptions to consumers. Here, this implies that $\kappa_j > 0$.

5.1 Consumer demand in the symmetric equilibrium

One result from Gal-Or and Dukes (2003) is that when platforms solely finance themselves through advertising revenues all consumers mix. Viewers then choose the optimal mix of programs by the two platforms and do not incur any transportation costs. With pay-tv competition this is not the case.

Proposition 1 *In the symmetric equilibrium, no mixing by consumers occurs.*

Proposition 1 says that every consumer will subscribe to exactly one platform. Pay-tv increases the cost of watching a program for every consumer and as a result consumers prefer to subscribe to only one of the platforms instead of subscribing twice but viewing their favorite programming mix. Proposition 1 also implies that we have to modify the analysis of consumer demand. Platforms' market shares and their payoffs in case of agreement and disagreement change, while producer profits remain the same. The market share of platform 1, when each consumer only subscribes to one platform, is $X^1 = \frac{1}{2} - R - \frac{\kappa_1 - \kappa_2}{2t_s}$, where R is as specified in Lemma 1. The market share of platform 2 is $X^2 = 1 - X^1$. Based on these market shares platforms have the following payoffs in case of agreement and disagreement:¹²

$$\begin{aligned}
 C_j &= a_A^j \varphi_A^j + a_B^j \varphi_B^j + X^j \kappa_j - f, \\
 C_j^{-i} &= a_l^j \varphi_l^j + \left(X^j + \frac{\gamma \varphi_i^j}{2t_s} \right) \kappa_j - f \quad j = 1, 2; \quad i \neq l.
 \end{aligned}
 \tag{16}$$

As compared to the case where platforms' only income are advertising revenues, their disagreement payoffs increase. This is due to the additional source of income for the platforms. In case of disagreement with one of the producers a platform now loses advertising revenue but still has an

¹²Also in case of disagreement among a platform-producer pair consumers have no incentive to mix between platforms.

income from selling subscriptions to consumers. This income even increases as a direct result of the disagreement. Disagreement leads to fewer advertisements on the platform and consequently attracts a higher number of consumers and fewer commercials attract more subscribers. This mechanism affects the bargaining outcome. The Nash bargaining solution with pay-tv is

$$a_i^j \varphi_i^j = \frac{p_i - c}{2} \left(X^j D_i^j + \frac{\gamma \varphi_i^j D_i^r}{2t_s} \right) + \kappa_j \frac{\gamma \varphi_i^j}{4t_s}. \quad (17)$$

As with free-to-air competition, the bargaining solution consists of the split profits from the sales on the product market and the premium paid to the platforms to compensate for the foregone viewers. With pay-tv competition the additional term $\kappa_j \frac{\gamma \varphi_i^j}{4t_s}$ appears in the bargaining outcome. It is a premium paid as a result of the forgone subscription revenues. In presence of subscription fees the disagreement between a platform and producer pair and consequently more viewers not only result in higher product market profits but also higher subscription revenues. This is taken into account during the bargaining process and thus increases the advertising payments. As subscription fees increase, so does the additional premium producers have to pay to platforms. In other words, by raising the subscription fee media platforms can improve their bargaining position vis-à-vis the advertisers. This is summarized by the following proposition:

Proposition 2 *On a pay-tv market, media platforms have higher disagreement payoffs than on a free-to-air market. This improves their bargaining position towards advertisers and results in higher advertising prices.*

In the related literature media outlets typically benefit from pay-tv competition because of a redistribution of rents between platforms and consumers (see e.g., Hoernig and Valletti, 2007). Mixing by viewers increases the surplus available to them on the media market, since the disutility from not consuming the preferred content is reduced. Platforms capture part of this surplus by raising subscription fees. This redistribution also takes place in our model but in addition there is a redistribution from producers to platforms. This is owed to the way advertising prices are determined in our model, namely via a bargaining process. As stated in Proposition 2 the subscription fee affects the platforms bargaining position and by this has a direct impact on advertising rates. The additional source of income helps platforms to extract rents from producers via the bargaining process. This, in turn, influences the producers' decisions on advertising intensities and thereby

affects competition and prices charged on the product market. The effect is more prominent when consumers' disutility from commercial interruptions is high. A switch from free-to-air to pay-tv competition then not only allows platforms to capture a part of their viewers' surplus but it also increases producer rents and advertising rates, as will be elaborated in more detail on the following pages. To our knowledge this effect has not been analyzed in the previous literature.

5.2 The symmetric equilibrium

Just as in the case of free-to-air competition producers maximize their payoffs with respect to prices and the advertising intensity, while taking the advertising rate as given. At the same time negotiations take place resulting in (17) and platforms maximize their payoffs with respect to the subscription fee κ_j . The price each platform charges to consumers is given by:

$$\kappa_j = t_s - \frac{\gamma((\varphi_A^j + \varphi_B^j) - (\varphi_A^r + \varphi_B^r))}{3}. \quad (18)$$

With asymmetric advertising intensities, the platform broadcasting more commercials charges a lower subscription fee. If advertising on platforms is symmetric, both will charge the same amount to consumers.

Producers face the following maximization problem in the symmetric equilibrium under pay-tv competition:

Lemma 2 *The following first-order conditions characterize producers' choices of advertising intensity and product prices in the symmetric equilibrium:*

$$\begin{aligned} \left. \frac{\partial F_i}{\partial \varphi_i^j} \right|_{Sym} &= (p - c) \left(X^j D^j T(\varphi^j) - \frac{\gamma(2D^j - D^r)}{4t_s} \right) - \frac{\gamma \kappa_j}{4t_s} = 0, \\ \left. \frac{\partial F_i}{\partial p_i} \right|_{Sym} &= (X^j D^j + X^r D^r) - (p - c) \left(X^j \frac{G(\varphi^j)^2}{2t_p} + X^r \frac{G(\varphi^r)^2}{2t_p} \right) = 0, \end{aligned} \quad (19)$$

where $X^1 \equiv \frac{1}{2} - \frac{\gamma(2\varphi^1 - 2\varphi^2)}{2t_s} - \frac{\kappa_1 - \kappa_2}{2t_s}$, $X^2 \equiv 1 - X^1$ and $D^j \equiv D_1^j = D_2^j = \frac{1}{2}[2 - G(\varphi^j)]G(\varphi^j)$.

Proposition 3 characterizes the symmetric equilibrium results for the case of pay-tv competition. All equilibrium results referring to pay-tv are denoted by "P".

Proposition 3 *In the symmetric equilibrium producers choose identical amounts of advertising and identical product prices. The amount of advertising messages by a producer broadcasted via each of the platforms is*

$$\varphi_P^* = T^{-1}\left(\frac{\gamma}{2t_s} + \frac{\gamma}{t_p(2 - G(\varphi_P^*))^2}\right). \quad (20)$$

Equilibrium product prices are

$$p_P^* - c = \frac{t_p(2 - G(\varphi_P^*))}{G(\varphi_P^*)}. \quad (21)$$

Platforms charge the same subscription fee to consumers in equilibrium,

$$\kappa^* = t_s. \quad (22)$$

This results in the following payoffs for both platforms and producers in the symmetric equilibrium:

$$\begin{aligned} C_P^* &= \frac{t_p[2 - G(\varphi_P^*)]^2}{4} \left(1 + \frac{\gamma\varphi_P^*}{t_s}\right) + \frac{\gamma\varphi_P^*}{2} + \frac{t_s}{2} - f, \\ F_P^* &= \frac{t_p[2 - G(\varphi_P^*)]^2}{4} \left(1 - \frac{\gamma\varphi_P^*}{t_s}\right) - \frac{\gamma\varphi_P^*}{2} - k. \end{aligned} \quad (23)$$

Charging a subscription fee affects the platforms' profit functions in two ways: First, the platform has an additional source of income and the revenues from selling subscriptions are represented by the term $\frac{t_s}{2}$ in the platforms' equilibrium profit function. Second, disagreement with one of the producers not only increases profits on the product market which are then split in the bargaining process but also increases subscription sales. As a result producers now also have to pay a premium to compensate for the foregone subscription revenues. This is represented by the term $\frac{\gamma\varphi_P^*}{2}$ which as a positive entry in platforms' and a negative entry in producers' equilibrium profits.

As in the case of free-to-air, a lower advertising intensity in equilibrium has a negative impact on both premiums as fewer consumers are to be gained in case of disagreement between a platform-producer pair. At the same time fewer advertisements increase prices on the product market but

have no impact on the subscription fee in equilibrium.

A change in the exogenous parameters of the model has similar effects. A higher product differentiation on the media market increases the equilibrium advertising intensity and product prices fall while the subscription fee increases. For platforms this means higher subscription revenues but a lower premiums paid by producers and lower overall producer revenues as a result of increased competition. A higher differentiation on the product market increases the equilibrium advertising intensity but has an ambiguous effect on equilibrium profits and prices. In contrast, a higher dislike for commercial interruptions leads to lower levels of advertising and higher product prices. The impact on platform profits is ambiguous as there are two opposing effects on the premiums paid to platforms. On the one hand, premiums increase as more consumers will shift in case of disagreement due to the increased dislike for commercial breaks. On the other hand, as equilibrium advertising levels decrease, fewer consumers can be gained by disagreeing with a producer. The effects of changes in parameters on prices and advertising levels are summarized in the following lemma:

Lemma 3 *In the equilibrium with pay-tv, i) a larger utility loss from not consuming the preferred content mix results in more advertisements, lower product prices and higher subscription fees; ii) more differentiation on the product market leads to more advertisements but has opposing effects on product prices; iii) a higher disutility of commercial breaks reduces advertising levels but increases product prices.*

5.3 Comparison with free-to-air

We are now able to compare the equilibrium results with pay-tv competition to the ones with free-to-air competition. Advertising intensities in equilibrium are higher with free-to-air competition. This result is intuitive, since platforms' improved bargaining power with pay-tv competition leads to higher advertising rates and therefore producers choose to advertise less in equilibrium, i.e. $\varphi_F^* > \varphi_P^*$. Furthermore, we can conclude that since there are fewer commercials with pay-tv competition prices charged to consumers on the product market are higher as compared to free-to-air competition, such that $p_F^* < p_P^*$. This can be explained by the following mechanism: fewer advertisements result in fewer informed consumers and consequently higher prices on the product

market due to alleviated competition.

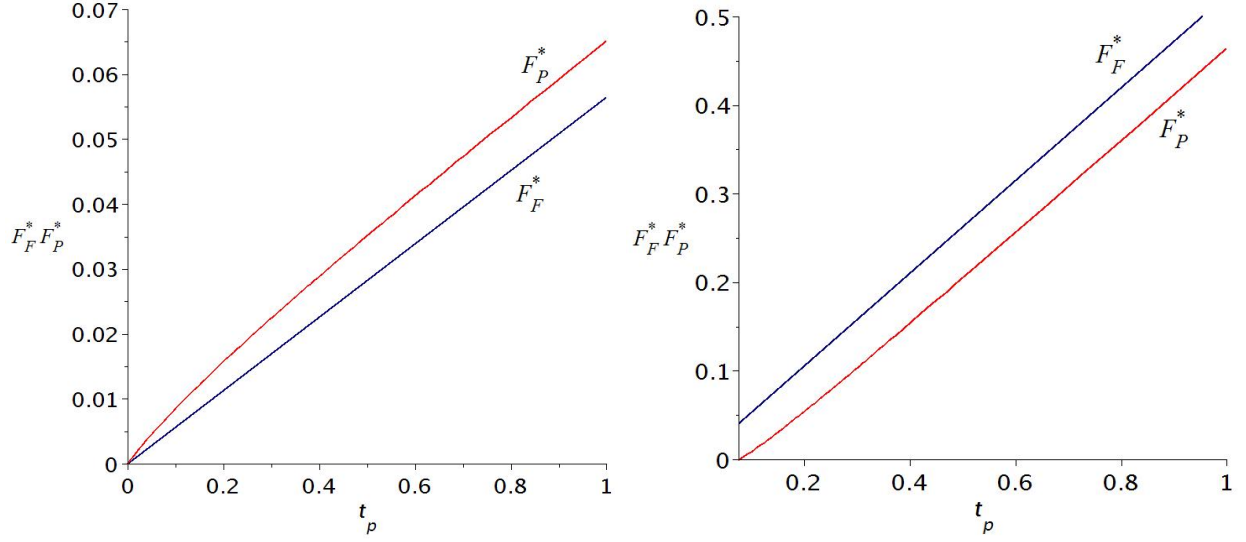
These changes in advertising prices and levels have an impact on payoffs of platforms and producers. Intuitively, platforms' profits should increase when switching from free-to-air to pay-tv competition as a result of higher bargaining power and the additional source of income. It is easy to see that this is also the case here, as producers have to pay an additional premium and there are now positive revenues from selling subscriptions. Yet, there are two opposing effects of a lower advertising intensity on profits. On the one hand, platform profits further increase because higher product prices lead to higher producer profits which are then split in the bargaining process. On the other hand, platform profits decrease because the premium paid by producers to compensate for foregone profits on the product market is lower.¹³

The change from free-to-air to pay-tv competition also has two implications for producer profits. As with platforms, profits increase due to higher profit margins and a partly lower premium. Profits also decline because of the increased bargaining power of platforms and the resulting increased advertising rates, i.e., the additional premium. Which effect dominates depends on how big the effect of a reduction in advertisements is on the outreach probability. This will determine how much the product price and therefore also producer revenues will increase after a switch to pay-tv. If changes in advertising intensity have a large effect on viewer product awareness producers can benefit from a switch to pay-tv, despite the additional premium they have to pay. To illustrate this point, Figure 1 shows producer profits in the symmetric equilibrium as the differentiation parameter for the product market increases, with two different examples of outreach probability functions, namely $G(\varphi) = (\varphi)^\eta$ and $G(\varphi) = (\varphi)^2 e^{-\varphi}$.¹⁴

¹³The assumption we made towards the elasticity of the outreach probability guarantees that the positive effect of a lower advertising intensity outweighs the negative one, i.e., as long as the elasticity of $G(\varphi)$ is non-increasing, $C_P^* > C_F^*$. The same proof used by Gal-Or and Dukes (2003) applies here, details are included in the Appendix as part of the proof of Proposition 4.

¹⁴Both functions, also used in Gal-Or and Dukes (2003), satisfy the assumptions made with respect to $G(\varphi)$ as long as $\frac{1}{2} < \eta < 1$ in the first function and $\varphi < \frac{3}{2}$ in the second function. All exogenous parameters were chosen such that $G(\varphi_F^*)$ is close to 0.5. The right graph is only shown for $t_p \geq 0.08$ as for all values smaller 0.08 producers have no incentive to participate in the market with pay-tv competition.

Figure 1: Equilibrium producer profits with different outreach probability functions: $G(\varphi) = \varphi^\eta$ (left) and $G(\varphi) = \varphi^2 e^{-\varphi}$ (right)



In both graphs equilibrium producer profits increase with the degree of differentiation on the product market. However, with $G(\varphi) = \varphi^\eta$ producer profits are higher with pay-tv for all values of t_p , while with $G(\varphi) = \varphi^2 e^{-\varphi}$ producer profits are always higher with free-to-air competition. In fact, for very low degrees of differentiation it would not be profitable for advertisers to stay in the market with pay-tv and this parametrization. Consequently, the effect of a change in business model by the platforms on producer profits remains ambiguous.

We summarize the comparison of free-to-air and pay-tv in the following proposition:

Proposition 4 *Compared to free-to-air, with pay-tv, i) advertising volume is lower and advertising rates are higher; ii) producer prices are higher; iii) platform profits are higher; iv) producer profits may be higher or lower.*

5.4 Consumer surplus and total welfare

In the symmetric equilibrium consumers derive utility from both the product and the media market. With free-to-air competition all consumers are able to choose their favorite programming mix and only have to bear the cost of commercial interruptions. With pay-tv none of the consumers mixes and they have to pay a subscription fee to the platforms. However, in the latter case there are also fewer advertisements. Overall consumer surplus in the symmetric equilibrium under the

two different pricing schemes is summarized below:

$$\begin{aligned}
CS_F^* &= (v_s - \gamma\varphi_F^*) + Z(\varphi_F^*), \\
CS_P^* &= \left(v_s - \gamma\varphi_P^* - \frac{13}{12}t_s\right) + Z(\varphi_P^*),
\end{aligned} \tag{24}$$

where $Z(\varphi_m^*) \equiv G(\varphi_m^*) \left[2 \left(v_p - \frac{1}{3}t_p - p_m^* \right) - G(\varphi_m^*) \left(v_p - \frac{7}{12}t_p - p_m^* \right) \right]$ and $m = F, P$. The first, bracketed part of both equations in (24) is the utility consumers derive from the media market, while $Z(\varphi_m^*)$ represents the utility they obtain on the product market. Viewers will always fare worse on the product market when platforms switch from free-to-air to pay-tv competition. Product prices increase and fewer advertisements imply less informed consumers and therefore more consumers that incur high disutilities or even abstain from making a purchase altogether. On the media market, however, consumers benefit from lower levels of advertising, but still have to pay a subscription fee and consume programming content that does not satisfy their tastes. The term $\frac{13}{12}t_s$, which only appears in the consumer surplus with pay-tv, contains both the subscription fee and the total transportation cost for consumers and decreases consumer surplus. However, the extra utility received from fewer commercial interruptions cannot compensate for the utility loss from the subscription fees, increased disutility on the media market and the lower utility derived from the product market. Hence, consumers always fare better with free-to-air competition.

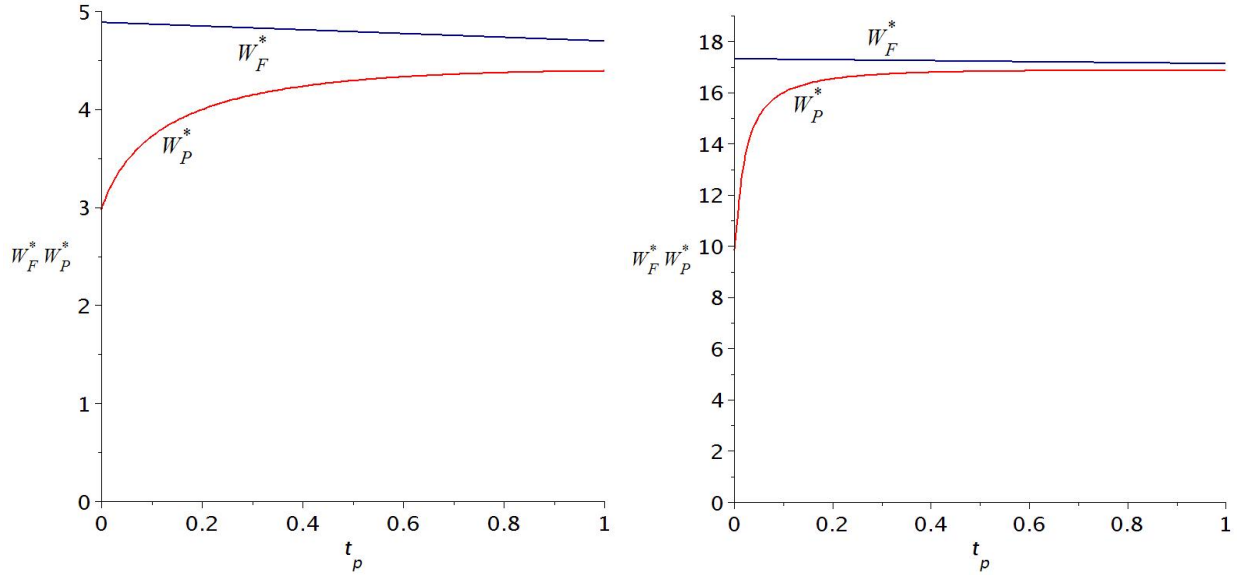
As we will see now, in our model welfare need not be decreasing when switching to pay-tv. Total welfare is the sum of the producer and platform profits and the consumer surplus:

$$\begin{aligned}
W_F^* &= t_p [2 - G(\varphi_F^*)]^2 - 2(f + k) + v_s - \gamma\varphi_F^* + Z(\varphi_F^*), \\
W_P^* &= t_p [2 - G(\varphi_P^*)]^2 - 2(f + k) + v_s - \gamma\varphi_P^* - \frac{1}{12}t_s + Z(\varphi_P^*).
\end{aligned} \tag{25}$$

Subscription fees only play an indirect role when comparing total welfare under the two forms of competition as they merely constitute a redistribution from consumers to platforms. However, subscription fees affect the mixing behavior of consumers and thereby also their utilities. There are three factors determining the welfare effects. Welfare in case of free-to-air competition tends to be higher due to a larger extent of consumer mixing and a higher coverage of the product market. However, a larger amount of advertising messages tend to reduce welfare with this form

of competition. It is unclear which effect dominates but we can derive certain conditions, under which welfare with free-to-air competition is higher than with pay-tv. For example, this is the case when the free-to-air equilibrium advertising intensity is low and the cost of transport on the product market is neither too high nor too low. Also, when looking at explicit functions for the outreach probability, the case is clear. Figure 2 shows that for the same functions and parameter values as in Figure 1 total welfare with free-to-air competition is always higher for $t_p \in [0, 1]$. This is the result of the substantially higher consumers surplus with free-to-air under both examples of the outreach probability function.

Figure 2: Equilibrium total welfare with different outreach probability functions: $G(\varphi) = \varphi^\eta$ (left) and $G(\varphi) = \varphi^2 e^{-\varphi}$ (right)



Furthermore, in both cases equilibrium welfare increases with higher differentiation on the product market with pay-tv but decreases with free-to-air. Also, an increase in the nuisance parameter increases welfare on the media market but decreases welfare on the product market. If viewers are not at all bothered by commercial interruptions (i.e., $\gamma = 0$), advertisement levels in the symmetric equilibrium are the same under both business models and total welfare is again higher with free-to-air than with pay-tv. In Proposition 5 the effects of the form of competition on consumer surplus and total welfare are summarized.

Proposition 5 *Compared to free-to-air, with pay-tv, i) consumer surplus is lower; ii) total welfare may be higher or lower.*

Table 1 contains a summary of our results and an overview of the comparison to the results of Gal-Or and Dukes (2003):

Table 1: Equilibrium results with free-to-air and pay-tv competition

Competition	Mixing	Consumers	Platforms	Producers	Welfare
Free-to-air	[0,1]	CS_F^*	C_F^*	F_F^*	W_F^*
	\vee	\vee	\wedge	$\vee\wedge$	$\vee\wedge$
Pay-tv	\emptyset	CS_P^*	C_P^*	F_P^*	W_P^*

Platforms prefer pay-tv over free-to-air competition, while consumers are better off with free-to-air. This is also due to the result that there are no mixing incentives with pay-tv competition whereas with free-to-air all consumers mix. Finally, advertisers have ambiguous preferences in our model and the effect of the form of competition on total welfare is ambiguous.

6 Conclusion

This paper analyzes two business models which are widely popular in media markets: free-to-air and pay-tv. The key ingredients of our model are the bargaining process by which platforms and producers determine advertising rates and informative advertising which can increase or reduce competition on the product market. On the consumer side, we consider a setting where consumers can allocate their viewing time on media platforms in order to reach their optimal consumption mix.

While many papers emphasize the advantages of markets with direct viewer payment, this paper highlights two disadvantages that may arise if the business model changes from free-to-air to pay-tv. The first effect is that media platforms can create additional market power in the advertising market. This is a result of platforms' improved bargaining position as direct viewer payments offer a strong outside option. With informative advertising, this increase in platforms' bargaining power has immediate repercussions on product market outcomes. Higher advertising rates and a lower advertising volume tend to decrease the competitiveness of the product market (i.e., less consumers are informed) and lead to higher prices for consumers. The second effect describes the change in consumers' optimal consumption mix of media products induced by a switch from free-to-air to

pay-tv. Here, the model makes a stark prediction. With free-to-air mixing is complete and each viewer consumes the ideal media mix. In contrast, with pay-tv, we find no mixing at all. As a result of not consuming their preferred content mix consumers face large disutility costs which constitutes a considerable welfare loss.

Appendix

Proof of Lemma 1. Consumers maximize their utility function $U(x)$ in (2) with respect to $\lambda(x)$. A consumer exclusively views platform 1 as long as $v_s - t_s x^2 - \gamma(\varphi_A^1 + \varphi_B^1) - \kappa_1 \geq U(x)$. A consumer exclusively views platform 2 as long as $v_s - t_s(1-x)^2 - \gamma(\varphi_A^2 + \varphi_B^2) - \kappa_2 \geq U(x)$. Substituting the optimal $\lambda(x)$ into both equations and solving for x yields the locations of those two consumers indifferent between exclusively viewing one platform and mixing between both. \square

Proof of Lemma 2. The maximization results in the symmetric case are obtained by substituting $\varphi_A^j = \varphi_B^j = \varphi^j$, $p_A = p_B = p$ and $a_A^j = a_B^j = a^j$ and $a_i^j = \frac{p_i - c}{2\varphi_i^j} \left(X^j D_i^j + \frac{\gamma \varphi_i^j D_i^r}{2t_s} \right) + \kappa_j \frac{\gamma}{4t_s}$ from equation (11). \square

Proof of Proposition 1. Platforms choose their optimal subscription fee by maximizing their payoffs $C_j = a_A^j \varphi_A^j + a_B^j \varphi_B^j + R_j \kappa_j - f$ with respect to κ_j , where $R_1 = 1 - \sqrt{\frac{\kappa_1}{t_s}} - R$ and $R_2 = 1 - \sqrt{\frac{\kappa_2}{t_s}} + R$. This takes place simultaneously to the bargaining process. The price each platform charges to consumers is then given by

$$\kappa_1 = \frac{4}{9}(1 - R)^2 t_s,$$

$$\kappa_2 = \frac{4}{9}(1 + R)^2 t_s.$$

However, according to Lemma 1 with these subscription fees there will be no mixing by consumers, as $\sqrt{\frac{\kappa_2}{t_s}} - R > 1 - \sqrt{\frac{\kappa_1}{t_s}} - R$. In this case, the platforms' demands will be defined by the viewers choice between the two media outlets and the platform j 's profit is

$$C_j = a_A^j \varphi_A^j + a_B^j \varphi_B^j + X_j \kappa_j - f,$$

where $X^1 = \frac{1}{2} - R - \frac{\kappa_j - \kappa_r}{2t_s}$. The subscription fee maximizing this profit function in the symmetric equilibrium satisfies the condition for no mixing, i.e., $R_0 \geq R_1$ since $1 \leq \sqrt{\frac{\kappa_1^*}{t_s}} + \sqrt{\frac{\kappa_2^*}{t_s}}$ with $R^* = 0$ and $\kappa_j^* = t_s$ (see Proposition 3). Given κ_2^* platform 1 could deviate by choosing a subscription fee κ_1 such that consumers could decide to mix, i.e., such that $1 - \sqrt{\frac{\kappa_2^*}{t_s}} \geq \sqrt{\frac{\kappa_1}{t_s}}$. This deviation,

however, cannot be profitable for platform 1 as $1 - \sqrt{\frac{\kappa_2^*}{t_s}} = 0$. \square

Proof of Proposition 2. For the first and second part of the proposition we compare platforms' disagreement payoffs and negotiated advertising rates under free-to-air with those under pay-tv. In case of free-to-air $\kappa_j = 0$.

$$C_j^{-i} = a_i^j \varphi_i^j + \left(X^j + \frac{\gamma \varphi_i^j}{2t_s} \right) \kappa_j - f,$$

$$a_i^j \varphi_i^j = \frac{p_i - c}{2} \left(X^j D_i^j + \frac{\gamma \varphi_i^j D_i^r}{2t_s} \right) + \kappa_j \frac{\gamma \varphi_i^j}{4t_s}.$$

Both expressions are increasing in the subscription fee κ_j . \square

Proof of Proposition 3. Product prices, advertising intensity and payoffs in Proposition 2 are obtained by substituting $X^1 = X^2 = \frac{1}{2}$, $D^1 = D^2 = \frac{1}{2}[2 - G(\varphi)]G(\varphi)$ and $\kappa_1 = \kappa_2 = t_s$ into equations (12) and the expressions for producer and platform profits. \square

Proof of Lemma 3. The following derivatives show the effects of the parameter changes in the equilibrium with pay-tv competition:

- i) $\frac{\partial \varphi_P^*}{\partial t_s} > 0$ as $T'(\varphi) < 0$; $\frac{\partial(p_P^* - c)}{\partial t_s} < 0$ since $\frac{\partial \varphi_P^*}{\partial t_s} > 0$, $G'(\varphi) > 0$ and $\frac{\partial(p_P^* - c)}{\partial G(\varphi_P^*)} < 0$; $\frac{d\kappa^*}{dt_s} = 1$.
- ii) $\frac{\partial \varphi_P^*}{\partial t_p} > 0$; $\frac{\partial(p_P^* - c)}{\partial t_p} \leq 0$ as $\frac{\partial \varphi_P^*}{\partial t_p} > 0$.
- iii) $\frac{\partial \varphi_P^*}{\partial \gamma} < 0$; $\frac{\partial(p_P^* - c)}{\partial \gamma} > 0$ since $\frac{\partial \varphi_P^*}{\partial \gamma} < 0$. \square

Proof of Proposition 4. i) Advertising volume with free-to-air is $\varphi_F^* = T^{-1}\left(\frac{\gamma}{2t_s}\right)$ while with pay-tv it is $\varphi_P^* = T^{-1}\left(\frac{\gamma}{2t_s} + \frac{\gamma}{t_p(2 - G(\varphi_P^*))^2}\right)$. Since $T'(\varphi) < 0$ and $\frac{\gamma}{t_p(2 - G(\varphi_P^*))^2} > 0$ it follows that $\varphi_F^* > \varphi_P^*$.

Equilibrium advertising rates with free-to-air competition and pay-tv are

$$a_F^* = \frac{t_p[2 - G(\varphi_F^*)]^2}{8\varphi_F^*} \left(1 + \frac{\gamma \varphi_F^*}{t_s} \right)$$

$$a_P^* = \frac{t_p[2 - G(\varphi_P^*)]^2}{8\varphi_P^*} \left(1 + \frac{\gamma \varphi_P^*}{t_s} \right) + \frac{\gamma}{4}.$$

The advertising rates with free-to-air can be rewritten as $a_F^* = \frac{t_p[2-G(\varphi_F^*)]^2}{8\varphi_F^*} \left(1 + 2\varphi_F^* T(\varphi_F^*)\right)$. Since the elasticity of $G(\varphi)$ is non-increasing, i.e. $\varphi_F^* T(\varphi_F^*) = \frac{\varphi_F^* G'(\varphi_F^*)}{G(\varphi_F^*)} - \frac{1}{2}$ is non-increasing, it follows that an increase in φ_F^* leads to a decrease in a_F^* . Since we have just established that $\varphi_F^* > \varphi_P^*$ it must be that $\frac{t_p[2-G(\varphi_F^*)]^2}{4} \left(1 + \frac{\gamma\varphi_F^*}{t_s}\right) < \frac{t_p[2-G(\varphi_T^*)]^2}{4} \left(1 + \frac{\gamma\varphi_T^*}{t_s}\right)$ and therefore also $a_F^* < a_P^*$.

ii) equilibrium prices of producers with free-to-air and pay-tv are

$$p_F^* - c = \frac{t_p[2 - G(\varphi_F^*)]}{G(\varphi_F^*)}$$

$$p_P^* - c = \frac{t_p(2 - G(\varphi_P^*))}{G(\varphi_P^*)}.$$

Since we have established under i) that $\varphi_F^* > \varphi_P^*$ it follows that $p_F^* < p_P^*$.

iii) Platform profits in equilibrium can be rewritten as

$$\frac{t_p[2 - G(\varphi_F^*)]^2}{4} \left(1 + 2\varphi_F^* T(\varphi_F^*)\right).$$

Following the same argument as in i), we can establish that since the elasticity of $G(\varphi)$ is non-increasing and $\varphi_F^* > \varphi_P^*$, $\frac{t_p[2-G(\varphi_F^*)]^2}{4} \left(1 + \frac{\gamma\varphi_F^*}{t_s}\right) < \frac{t_p[2-G(\varphi_P^*)]^2}{4} \left(1 + \frac{\gamma\varphi_P^*}{t_s}\right)$ and therefore $C_P^* > C_F^*$.

iv) Producer profits in equilibrium with free-to-air and pay-tv are

$$F_F^* = \frac{t_p[2 - G(\varphi_F^*)]^2}{4} \left(1 - \frac{\gamma\varphi_F^*}{t_s}\right) - k$$

$$F_P^* = \frac{t_p[2 - G(\varphi_P^*)]^2}{4} \left(1 - \frac{\gamma\varphi_P^*}{t_s}\right) - \frac{\gamma\varphi_P^*}{2} - k.$$

We have established under i) that $\varphi_F^* > \varphi_P^*$ which increases producer profits under pay-tv in equilibrium. At the same time, however, profits decrease because of the additional term $\frac{\gamma\varphi_P^*}{2}$. As the magnitude of the change in φ^* cannot be determined, equilibrium producer profits could be higher or lower when switching from free-to-air to pay-tv competition. \square

Proof of Proposition 5. The consumer surplus with free-to-air and with pay-tv is

$$CS_F^* = (v_s - \gamma\varphi_F^*) + Z(\varphi_F^*),$$

$$CS_P^* = (v_s - \gamma\varphi_P^* - \frac{13}{12}t_s) + Z(\varphi_P^*),$$

The consumer surplus derived from the product market is always lower with pay-tv competition in the symmetric equilibrium, i.e. $Z(\varphi_P^*) < Z(\varphi_F^*)$. This can be verified by looking at the sign of the derivatives of $Z(\varphi_m^*)$ with respect to the outreach probability and product prices in equilibrium: $\frac{\partial Z(\varphi_m^*)}{\partial G(\varphi_m^*)} > 0$ and $\frac{\partial Z(\varphi_m^*)}{\partial p_m^*} < 0$. In the proof of Proposition 4 we established that $\varphi_F^* > \varphi_P^*$ and $p_F^* < p_P^*$, it follows that $Z(\varphi_P^*) < Z(\varphi_F^*)$.

The only way that consumers could obtain a higher surplus is if the surplus generated on the media market was higher with pay-tv. This is the case when $CS_P^{media} > CS_F^{media}$, that is when $\frac{t_s}{\gamma} < \frac{12}{13}(\varphi_F^* - \varphi_P^*)$. At the same time both platforms and producers need to have an incentive to participate in the market in the symmetric equilibrium. For platforms this is always the case, as long as the fixed operation costs are not too high. For producers on the other hand, in addition to low cost of production, the premium they pay to platforms in equilibrium must not be too high. Producer profits will not be positive with either business model if the following condition does not hold: $1 - \frac{\gamma\varphi_F^*}{t_s} > 0$. Rewriting this yields $\frac{t_s}{\gamma} > \varphi_F^*$. However, this is in contradiction with $CS_P^{media} > CS_F^{media}$ and therefore consumer surplus with pay-tv will always be lower than with free-to-air.

Total welfare with free-to-air and pay-tv is

$$W_F^* = t_p[2 - G(\varphi_F^*)]^2 - 2(f + k) + v_s - \gamma\varphi_F^* + Z(\varphi_F^*),$$

$$W_P^* = t_p[2 - G(\varphi_P^*)]^2 - 2(f + k) + v_s - \gamma\varphi_P^* - \frac{1}{12}t_s + Z(\varphi_P^*).$$

Switching to pay-tv only produces a higher total welfare than with free-to-air if the benefits for the platforms and producers outweigh the negative impact on consumer surplus. This is the case when $W_F^* - W_P^* > 0$, that is when $\Delta W^* = 12t_s - \gamma(\varphi_F^* - \varphi_P^*) + 2(v_p - \frac{7}{3}t_p)[G(\varphi_F^*) - G(\varphi_P^*)] - (v_p - \frac{19}{12}t_p)[G(\varphi_F^*)^2 - G(\varphi_P^*)^2] + p_P^*G(\varphi_P^*)[2 - G(\varphi_P^*)] - p_F^*G(\varphi_F^*)[2 - G(\varphi_F^*)] > 0$ and this is the case as

long as $G(\varphi_F^*) \leq 0.5$ and $c < t_p < \frac{12}{37}v_p$. \square

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