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A B S T R A C T

We develop a two-sided market model with an upstream–downstream structure. More specifically, the platform consists of two rival upstream firms and a downstream monopolist. Each upstream firm negotiates the input price (license fee) with the downstream monopolist and also chooses the amount of advertising that is embedded in the good it sells to the downstream monopolist. The downstream monopolist can offer the two goods either on an à la carte basis or as a bundle. We use this model to understand the incentives to bundle and the welfare properties of bundling in a two-sided market framework. We also contribute to the ongoing debate on à la carte pricing in the TV industry, where the two upstream firms can be viewed as two rival TV networks and the downstream monopolist as a cable operator. We show that an à la carte regulation will raise consumer surplus and downstream profit, while it will decrease the profits of the upstream TV networks.

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1. Introduction

Cable prices, whether on an unadjusted or quality-adjusted basis, have been rising faster than inflation. Crawford et al. (2008), report that unadjusted cable prices increased by 84.1% over 1997–2005, while the increase was 50.5% when adjusted for quality improvements. In the same period, the increase in the CPI was only 18.8%. Consumer groups and politicians assert that the bundling practices by cable TV providers have contributed to the steep price increases. À la carte pricing is promoted as a remedy for higher cable prices. In May 2013, Senator John McCain introduced a bill that would rely on a variety of incentives in order to induce cable operators into offering channels on an à la carte basis.1

Cable industry trade groups oppose the idea of à la carte pricing. They argue that bundling lowers transaction costs, realizes economies of scale, simplifies consumers’ decision-making process, and à la carte pricing will hurt consumers by driving up prices. The attitude of the FCC towards à la carte pricing has historically been somewhat neutral, although both former FCC Chairman Kevin Martin and current FCC Chairman Tom Wheeler have made public statements espousing some potential benefits of à la carte regulation.2 For example, in October 2014 Mr. Wheeler

1 Television Consumer Freedom Act of 2013, S 912, 113th Cong., 1st sess.
2 While the discussion of à la carte pricing has been predominantly focused on the cable television industry, primarily as a response to rising
proposed that online video providers be allowed to offer cable and broadcast stations on an à la carte basis. The FCC has stopped short of explicitly supporting a universal à la carte regulation, however. This may, perhaps, be in response to uncertainty regarding the likely implications of an à la carte regulation. Indeed, the FCC has published two studies on à la carte pricing (one in 2004 and the other in 2006) that draw contradictory conclusions. The lack of consensus illustrated by the FCC’s own reports is echoed in the academic literature, as we discuss in Section 1.1. In this paper, we develop a model to contribute to the ongoing debate about whether TV cable operators should be forced to offer channels à la carte.3

More precisely, we construct a two-sided market model with an upstream–downstream structure to examine the welfare properties of bundling.4 There is a substantial body of work on bundling in one-sided markets,5 but very few in two-sided market environments.6 We model a downstream monopolist who purchases two goods from two rival upstream suppliers. Each upstream firm chooses the amount of advertising that is embedded in the good and negotiates with the downstream monopolist over the input price. The downstream monopolist can offer the goods either on an à la carte basis or as a bundle. We assume that consumer valuations for the two goods follow a bivariate normal distribution with a correlation coefficient anywhere between –1 and 1. Consumers dislike advertising, but advertisers’ profit is increasing in the number of final consumers. Hence, the platform in our model consists of the two upstream firms and the downstream monopolist, and the two sides are advertisers and consumers (viewers).

Our model allows us to shed light not only on the incentive to bundle, but also on how bundling interacts with the amount of advertising and the level of input prices, which are important determinants of the final prices and, hence, consumer welfare. Due to the complexity of the model, our solutions are numerical.7

We use the model to contribute to the policy debate on à la carte regulation. À la carte regulation will force the monopolist to break the bundle and sell the goods individually. We identify three effects on consumer welfare as we move from pure bundling to à la carte: i) sorting effect, ii) license fee effect and iii) advertising effect. The bundle reduces consumer heterogeneity and allows the monopolist to extract more surplus, hence the sorting effect increases consumer welfare. The license fee (and thus the final price) may go either up or down, depending on the size of the market (i.e., number of viewers). Finally, advertising levels decrease, which benefits consumers.

The net effect is in general ambiguous, but when we choose parameter values that are reasonably close to estimated parameters from the empirical literature on the TV industry (Crawford and Yurukoglu, 2012), we find that à la carte will raise final prices, lower advertising levels and benefit both consumers and the downstream cable operator. The effect on license fees is ambiguous and it depends on the correlation of valuations coefficient. Consumers benefit both because they can pick and choose the channels they really like and because advertising decreases. In contrast, the profits of the upstream TV networks will decrease.

1.1. Related work and our contribution

Rennhoff and Serfes (2009) and Crawford and Yurukoglu (2012) are the closest papers to our work. Rennhoff and Serfes (2009) develop a theoretical upstream–downstream model to study the incentives of downstream firms to bundle their goods. Within this framework, the authors investigate the impact of an à la carte regulation. Crawford and Yurukoglu (2012) also model the vertical channel and using a rich dataset from the TV industry they estimate the key model parameters and perform a counterfactual à la carte simulation. They find that an à la carte regulation will raise license fees and (most likely) reduce consumer welfare. However, Rennhoff and Serfes (2009) do not include the advertising side, while Crawford and Yurukoglu (2012), although they include advertising revenue, do not model the competition among TV channels for advertisers. In particular, the advertising fees (and levels) do not respond when the market switches from pure bundling to à la carte pricing (the advertising revenue, however, does respond because the number of viewers changes). Modeling the advertising side more explicitly enables us to offer novel insights about the interplay between the downstream pricing regime and upstream competition for advertisers. For example, we show that advertising levels decrease when the market moves to à la carte (relative to pure bundling), which impacts consumer surplus positively. Therefore, prior studies have underestimated the effect of à la carte pricing on consumer welfare.

Three other contributions relative to Crawford and Yurukoglu are the following. First, our model allows us to highlight the role of the correlation coefficient. The correlation coefficient (which affects, among other model parameters, the size of the market) determines whether the license fees will decrease or increase in the à la carte

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3 For simplicity, we generally use the term “TV cable operators” to refer to multichannel video programming distributors (MPVD), which includes traditional cable distributors, such as Comcast or Cablevision, as well as satellite providers, such as DirecTV.

4 Classic papers on two-sided markets (but with no bundling) are Spulber (1999), Caillaud and Julien (2003), Armstrong (2006) and Rochet and Tirole (2003).

5 See, for example, Adams and Yellen (1976), Schmalensee (1984), McAfee et al. (1989) and Bakos and Brynjolfsson (1999).

6 An exception is the paper by Chao and Derdenger (2013) who examine the incentives of a monopolist to bundle in the context of the portable video game console market. Their model and results are very different from ours. Amelio and Julien (2007), Choi (2010) and Rochet and Tirole (2008) investigate tying in two-sided markets.

7 Crawford and Cullen (2007) also examine the effects of à la carte pricing numerically, but in a one-sided environment. Chu et al. (2011) analyze the optimality of alternative bundling strategies in markets with many goods using numerical methods.
regime. Second, we decompose the total change in profits/welfare due to à la carte to three effects associated with our model: sorting, advertising and license fee effects. This allows us to isolate each effect in order to gain a deeper understanding of the different aspects of the model and to contribute to the policy debate on à la carte pricing. Finally, although our main simulation results are based on parameter values that are reasonably close to estimated parameters from the empirical literature on the TV industry, we also perform comparative statics with respect to some of the key model parameters (such as the average consumer valuation, the correlation coefficient of consumer valuations for the two goods and the consumer disutility from advertising) in order to gain broader insights that would be applicable to other two-sided markets with an upstream-downstream structure.

The remainder of the paper is organized as follows. The main model is presented in Section 2. In Section 3 we evaluate the implications of la carte pricing. We conclude in Section 4. Appendix A contains details regarding the simulation algorithm and robustness checks.

2. The model

A two-sided platform is comprised of two upstream firms, \( i = a, b \), and one downstream firm. Each upstream firm sells one product to the downstream firm, which, in turn, sells them to final consumers. Each product also contains an amount of advertising, which is chosen by the upstream firms. Advertisers’ profits depend positively on the number of final consumers, while consumers derive negative utility from advertising.\(^8\) In this paper, we assume that the two goods are two TV channels/networks (e.g., CNN and Fox News) and the downstream firm is a cable operator (e.g., Comcast). We use the word ‘channel’ to refer to a ‘good’. Fig. 1 describes the structure of the model. The upstream TV channels have two sources of revenue: license fee and advertising fee, while the downstream monopolist earns revenues from the consumers (subscribers).

The downstream monopolist packages and sells the two goods \((a \text{ and } b)\) to consumers. The monopolist can choose to offer these two goods either à la carte (interchangeable with “no bundling”), or together as a bundle (defined as “pure bundling”). Under à la carte, consumers are allowed to build the bundle on their own by paying the sum of the stand-alone prices. Under pure bundling, consumers choose to either buy the bundle or nothing.

We assume that consumer maximum willingness to pay for the two goods, \((v_a, v_b)\), follows a bivariate normal distribution with mean \((\mu_a, \mu_b)\), variance \((\sigma^2_a, \sigma^2_b)\) and covariance \(\sigma_{ab}\). We denote the density by \(f(v_a, v_b)\) and the marginal density by \(f_i(v_i)\). The amount of advertising on channel \(i\) is \(\alpha_i\). Advertising imposes disutility on consumers (viewers) with \(t\) capturing the per-unit nuisance cost from advertising. Hence, consumer net utility from each channel is equal to \(v_i - t\alpha_i - p_i\), where \(p_i\) is the price for channel \(i\). Consumers, taking the advertising levels on each channel and the prices as given, buy the option which gives them the highest utility.

2.1. Downstream firm profit

We assume that the downstream monopolist has two options to offer the two channels: i) no bundling (à la carte) and ii) pure bundling. Mixed bundling is a third option, but we ignore it because our focus in this paper is on the price and welfare effects of a movement from pure bundling (which is what is observed in reality in the TV industry) to à la carte. We discuss each option separately.

2.1.1. No bundling (à la carte)

Since the channels are offered separately, viewers will purchase channel \(i\) if and only if the channel valuation exceeds the disutility from advertising and the price, \(v_i - t\alpha_i + p_i\). Therefore, the corresponding demand for each channel is \(\) (see also Fig. 2)

\[
d_i = \int_{t\alpha_i + p_i}^{\infty} f_i(v_i)dv_i = 1 - F_i(p_i + t\alpha_i), \quad i = a, b.
\]
Only channel \( b \). A consumer purchases the bundle and watches only channel \( b \) if and only if
\[
v_b \geq t \alpha_a + p_B \quad \text{and} \quad v_a < t \alpha_b,
\]
with mass of consumers given by
\[
d_b = \int_{-\infty}^{t \alpha_a} \int_{p_B + t \alpha_a}^{\infty} f(v_a, v_b) dv_a dv_b.
\]

Both channels. Finally, a consumer purchases the bundle and watches both channels if and only if
\[
v_a + v_b \geq t \alpha_a + t \alpha_b + p_B, \quad v_a \geq t \alpha_a \quad \text{and} \quad v_b \geq t \alpha_b,
\]
with mass of consumers given by
\[
d_B = \int_{-\infty}^{\infty} \int_{p_B + t \alpha_a}^{\infty} f(v_a, v_b) dv_a dv_b
\]
\[
+ \int_{-\infty}^{\infty} \int_{p_B + t \alpha_b}^{\infty} f(v_a, v_b) dv_a dv_b.
\]

The monopolist’s demand function is \( D_{PB} = d_a + d_b + d_B \), which represents the mass of subscribers, while the number of viewers for channel \( a \) is \( q_a = d_a + d_B \) and for channel \( b \) is \( q_b = d_b + d_B \). This distinction is necessary as the number of viewers will later be used to determine the advertising demand, since advertisers care about the number of viewers (and not about the number of subscribers). The profit function of the monopolist is
\[
\Pi_{PB} = D_{PB}(p_B - c_a - c_b)
\]
which is maximized with respect to the bundle price \( p_B \).

### 2.2. Upstream firms’ profits

The upstream firms’ revenues are composed of two parts: the license fee paid by the downstream operator and the advertising fee paid by the advertisers. Let \( c_i \) be the linear license fee per subscriber.\(^9\) The cable operator needs to pay the license fee for each subscriber no matter whether the subscriber watches this channel or not. The profit from the license fee is
\[
\Phi_i^L = c_i D_i
\]
where \( D_i \) is the number of subscribers that channel \( i \) has, i.e. \( D_i = d_a + d_b + d_B \) in pure bundling.

We assume that the advertiser willingness-to-pay will increase by \( n \) (where \( n > 0 \)) if the number of viewers increases by 1. If we imagine the advertiser as the seller of a consumer product, this assumption is consistent with the notion that, holding all else constant, exposure to more viewers increases the number of purchases the firm expects to yield from a given advertisement.\(^10\) The higher the value of \( n \), the more valuable viewers are to the advertisers. Also, the advertiser willingness-to-pay for a spot on channel \( i \) decreases when the rival channel \( j \) has more viewers. We further assume that advertising

\(^9\) While the assumption of a linear input price is not general, linear per-subscriber fees are the norm in the TV industry.

\(^10\) Our modeling assumptions here are quite simplistic. We ignore, for example, the potential that different types of consumers might be more/less valuable to advertisers.
spots are more valuable when a channel or the rival channel air fewer advertisements (advertising spots on the two channels are substitutes from the perspective of the advertisers). Therefore, we assume that the inverse demand for advertising on channel $i$ is

$$g_i = \kappa_1 + nq_i - n\kappa_2 a_j - \alpha_i - \kappa_3 \alpha_j. \quad (3)$$

where $g_i$ is the advertising fee for advertising on channel $i$, $q_i$ is the total number of channel $i$ viewers, $a_j$ is the total number of viewers in the rival channel $j$, $\alpha_i$ is the level of advertising on channel $i$ and $\alpha_j$ is the level of advertising on the rival channel $j$. We assume that $\kappa_1 \geq 0$, $0 \leq \kappa_2 < 1$ and $0 \leq \kappa_3 < 1$. The degree of substitutability of the advertising spots between the two channels is measured by $\kappa_3$.11

The profit from advertising is given by

$$\Phi^A = g_i \alpha_i.$$

Thus, TV channel $i$’s profit function is given by

$$\Phi_i = \Phi^A_i + \Phi^N_i = c_i D_i + g_i \alpha_i. \quad (4)$$

TV channel $i$ chooses the amount of advertising $\alpha_i$ to maximize $\Phi_i$. Moreover, it negotiates with the downstream cable operator over the license fee $c_i$. We turn to this negotiation process next.

2.3. Bargaining between an upstream firm (TV channel) and the downstream monopolist over the license fee

We assume that the license fee is determined 
via bilateral Nash Bargaining between each upstream firm and the downstream monopolist (Hart and Tirole, 1990; Horn and Wolinsky, 1988; McAfee and Schwartz, 1994, and Segal and Whinston, 2003). The downstream firm will bargain with each upstream firm (i.e. Comcast-CNN and Comcast-Fox News) separately and simultaneously. We assume that upstream firms have ‘passive beliefs’, so if an upstream firm receives an out-of-equilibrium offer from the downstream monopolist it still believes that the offer to the other upstream firm is at its equilibrium level. Each pair of upstream and downstream firms will choose the license fee $c_i$ to maximize the Nash product. The Nash Product for the bargaining over the license fees between the downstream monopolist (cable operator) and TV channel $i$ is defined as follows:

$$N^i = (\Pi^Y - \Pi^N)^{\lambda} (\Phi^Y - \Phi^N)^{(1-\lambda)}, \quad (5)$$

where $\lambda$ is the bargaining power of the downstream monopolist.

2.3.1. No bundling

In the no bundling case, if the cable operator and network $i$ reach an agreement, the cable operator’s profit will be the maximum of (1) with respect to the stand-alone prices $p_0$ and $p_b$, denoted by $\Pi^N$. Network $i$’s profit is $\Phi^N_i = \Phi_i$, see (4). When the cable operator and network $i$ do not reach an agreement, the cable operator’s profit will become the profit from offering only channel $j$, $\Pi^N_j = \pi_j = (1 - \lambda_i)(p_j - c_j)$, which is maximized with respect to $p_j$. Network $i$’s profit is zero (there is also no advertising revenue because the number or viewers is zero), $\Phi^N_i = 0$. Therefore, we can explicitly write down the Nash bargaining product function as follows:

$$N^i_{PB} = (\Pi^N - \Pi^Y)^{\lambda} (\Phi^N - \Phi^Y)^{(1-\lambda)},$$

which is maximized with respect to the license fee $c_i$.

2.3.2. Pure bundling

The Nash bargaining products for the pure bundling case can be derived similarly using (2) and (4).

2.4. The two-stage game

Our model can be represented by the following two-stage game

• Stage 1: Given the selling method, pure bundling or à la carte, the upstream television channels set advertising levels, $\alpha_i$, which determines the advertising fee $g_i$, and simultaneously, each upstream firm negotiates with the downstream firm over license fees, $c_i$.12

• Stage 2: The downstream monopolist chooses final prices, $p_i$.

We solve the game backwards. In stage 2 we solve for the prices that maximize the monopolist’s profits, (1) in NB and (2) in PB, as a function of the advertising levels and license fees. The profit-maximizing prices are given by $p_i(\alpha_a, \alpha_b, c_a, c_b)$, $i = a, b$ in case of NB and $p_b(\alpha_a, \alpha_b, c_a, c_b)$ in case of PB. In stage 1, using the downstream price functions and given the selling method, each upstream firm chooses the advertising level $\alpha_i$ to maximize own profits, as given by (4), and the license fee $c_i$ to maximize the Nash product, as given by (5).

Due to the complexity of the model analytical solutions are impossible to obtain. Therefore, we solve for the equilibria numerically.13 The key parameters of the model that affect the equilibrium outcomes are: (1) Mean $\mu_i$, standard deviation $\sigma_i$, and correlation $\rho$ of the viewer valuations for the two TV channels; (2) The cross-group externalities, $t$ and $n$ that measure the strength of the feedback loop in our two-sided model (disutility from advertising and value of viewers to advertisers, respectively); (3) The degree of substitutability of the advertising slots in the two channels, $\kappa_3$ and (4) The bargaining power parameter $\lambda$ (a higher value implies higher bargaining power for the downstream cable operator).

We search for a symmetric equilibrium. Hence, in the tables that follow we only present the price of one good ($p$ if the good is sold à la carte and $p_b$ for the bundle price), the level of advertising $\alpha$ on one channel and one

11 Essentially, we have assumed a Singh–Vives type of demand (Singh and Vives, 1984). We implicitly have assumed that there is a representative advertiser who views the two channels as substitutes but advertisers on both. The amount of advertising each advertiser chooses depends on the advertising fees and the number of viewers.

12 This assumption implies that at the stage of license fee negotiations between a TV network and a cable operator, the TV network has not yet committed (or cannot credibly commit) to the number and duration of commercials that will be aired.

13 Details of our numerical algorithm appear in Appendix A.
license fee $c$. The total number of viewers/subscribers on one channel is denoted by $q/D$ (these two differ in pure bundling), the profit of each upstream TV channel by $\pi^U$ and the downstream monopolist’s profits by $\pi^D$. Finally, CS denotes consumer surplus and AS the surplus to advertisers (to economize on space, we do not report AS in the tables).

Consumer surplus is the area under the inverse demand curve above the final price and advertising surplus (AS) is the area under the inverse demand for advertising above the equilibrium advertising fee $g^*(\alpha^*_t, \alpha^*_c)$. This is expressed as follows:

$$AS = \int_0^{\alpha_1^*} [g_i(\alpha_i, \alpha^*_c) - g^*_i(\alpha^*_t, \alpha^*_c)] d\alpha_i.$$ 

Total surplus is defined as the sum of consumer surplus, downstream firm profit, upstream firms’ profits and advertiser surplus

$$TS = CS + \pi^D + 2\pi^U + 2AS.$$ 

The results at the end of each subsection summarize the main novel findings from each case.

### 3. Simulation results: à la carte regulation in the TV industry

We evaluate the welfare implications of an à la carte regulation in the TV industry. We assume, as is the case in reality, that the status quo is PB and then a regulator forces the downstream cable operator to sell the two channels à la carte, NB. We anchor our model parameters to plausible values from the empirical literature on the TV industry as follows. First, we set the mean valuations equal to $\mu_1 = \mu_2 = 4.5$ and the standard deviation equal to $\sigma_1 = \sigma_2 = 5.5$. These values are reasonably close (given also the symmetry we have assumed) to the estimates for CNN and Fox News Channel in Crawford and Yurukoglu (2012). Second, we set the bargaining parameter equal to $\lambda = 0.41$. Finally, we choose the following values for the remaining parameters: $n = 1.7$, $t = 1$, $\kappa_1 = 1.5$, $\kappa_2 = 0.05$ and $\kappa_3 = 0.1$. These values were chosen so that the equilibrium license fees in the PB case, when the correlation of the valuations is negative (a reasonable assumption for CNN and Fox News), are reasonably close to the estimated values reported in Crawford and Yurukoglu.\(^1\)

**Definition 1.** The total effect is the change in profits, prices, and welfare, from PB to NB.\(^1\)

The total effect captures a transition from bundling to à la carte when all endogenous variables are allowed to vary. Table 1 presents the simulation results for the status quo case of PB when the correlation coefficient $\rho$ assumes three different values: $-0.5$, 0 and 0.5 and the equilibrium values for the à la carte scenario, NB.\(^1\)

If we focus on the $\rho = -0.5$ case (which as we argued above is empirically plausible), we can see that an à la carte regulation (from PB to NB) will increase the license fees $c$, decrease the levels of advertising $\alpha$, benefit consumers and the downstream operator, but it will hurt the upstream firms.

There are three effects associated with an à la carte regulation, relative to pure bundling: (1) sorting effect, (2) advertising effect and (3) license fee effect. First, pure bundling is used to reduce the heterogeneity of consumer valuations and to extract more consumer surplus. The lower the correlation of consumer valuations the better the sorting effect works for the monopolist. An à la carte regulation is likely to benefit consumers and this benefit increases as the correlation decreases. Second, à la carte attracts fewer subscribers (and viewers) relative to pure bundling and also changes the way the two TV channels compete for advertisers. In general, the advertising levels and profits from advertising can either increase or decrease. Advertising levels, in turn, affect consumer surplus. Finally, an à la carte regulation may increase or decrease the license fee, which directly affects the final price. Notice that the effective price per channel is higher under NB. Consumers, in the aggregate, are unambiguously better off, however. This is possible because NB (relative to PB) allows consumers greater choice freedom and simultaneously reduces the amount of advertising on each channel. These are the sorting and advertising effects and are discussed in greater detail in the exposition that follows.

In order to extract deeper insights from the model, we quantify and isolate each one of the three effects and we offer an intuition for each one of them. We base this exercise on the chosen parameter values, but the intuition we offer can be generalized. The three effects are presented in Fig. 4.

\(^{14}\) See Table 4 in Crawford and Yurukoglu. The mean willingness to pay (WTP) and standard deviation of the WTP for CNN are $(5.38, 5.91)$, while for Fox News Channel are $(4.07, 5.89)$.\(^{15}\)

\(^{15}\) Our choice is based on previous empirical work. Table 7 in Crawford and Yurukoglu presents estimates for the bargaining parameters of the channel conglomerates versus distributors of various types. The parameter for News Corporation (Fox Channel News) is 0.42 and for Time Warner (CNN) is 0.40, versus a big cable operator.

\(^{16}\) Table 9 in Crawford and Yurukoglu shows that the estimated license fee for CNN is 0.49 and for Fox News Channel is 0.36. Moreover, in à la carte, the license fee of CNN increases to 2.92 and of Fox News to 1.83. In Table 1 the license fee under pure bundling is 0.542 and in à la carte it increases to 1.403.
Table 2
Advertising and license fees fixed at the PB equilibrium.

<table>
<thead>
<tr>
<th>ρ</th>
<th>p</th>
<th>α</th>
<th>c</th>
<th>q</th>
<th>π₀</th>
<th>π₁</th>
<th>CS</th>
<th>TS</th>
</tr>
</thead>
<tbody>
<tr>
<td>−0.5</td>
<td>5.717</td>
<td>0.938</td>
<td>0.542</td>
<td>0.348</td>
<td>3.598</td>
<td>1.154</td>
<td>2.566</td>
<td>9.455</td>
</tr>
<tr>
<td>NB₂</td>
<td>0</td>
<td>6.148</td>
<td>0.921</td>
<td>1.224</td>
<td>0.320</td>
<td>3.154</td>
<td>1.317</td>
<td>2.290</td>
</tr>
<tr>
<td>0.5</td>
<td>6.381</td>
<td>0.920</td>
<td>1.589</td>
<td>0.305</td>
<td>2.926</td>
<td>1.388</td>
<td>2.145</td>
<td>8.786</td>
</tr>
</tbody>
</table>

(α, c and the selling method vary: Total effect)

PB (Table 1)  NB₁ (Table 1)

(α, c fixed at PB but selling method varies: Sorting effect)

PB (Table 1)  NB₂ (Table 2)

(c fixed at PB and selling method fixed at NB--α varies: Advertising effect)

NB₂ (Table 2)  NB₃ (Table 3)

(α fixed at PB and selling method fixed at NB--c varies: License fee effect)

NB₂ (Table 2)  NB₄ (Table 4)

Fig. 4. The three effects: sorting, advertising and license fee. The subscripts in NB match the table number in which this case is presented.

3.1. Sorting effect

Definition 2. The sorting effect is the change in profits, prices and welfare, from PB to NB₂, holding the advertising levels α and the license fees c fixed at the PB levels.

To derive the sorting effect we need to compare the equilibrium values in Table 2 with those for PB in Table 1, holding ρ the same. The sorting effect is positive for consumer surplus and downstream profits and negative for upstream profits (in Table 5 we summarize all three effects). Consumers benefit from à la carte, despite the fact that the sum of the à la carte prices in NB are higher than the bundle price in the PB regime (for all three correlation parameter values). This is because consumers, under à la carte, are not forced to purchase both channels. The downstream monopolist also benefits. We can better understand this using demand rotation and the relative positions of the marginal and the average consumers (e.g., Johnson and Myatt, 2006). Under the status quo case of PB, the willingness to pay (WTP) of the average consumer (average valuation minus the disutility from advertising) is lower than the price and hence the willingness to pay of the marginal consumer (niche market). When we move to à la carte the inverse demand becomes steeper, suggesting that the WTP of the marginal consumer increases and so do the profits. As the correlation decreases the sorting effect works better for the downstream monopolist. This is because a low correlation implies a flat demand function under PB and, in a niche market, the relative increase in the slope of the demand when the market switches to NB (and hence the profits of the monopolist) is bigger, than when the correlation is high. This ranking of profits would reverse if we were in a mass market, where the price would be below the mean valuation.¹⁸

Result 1 (Sorting effect): Pure bundling flattens the inverse demand and allows the monopolist to extract more consumer surplus. À la carte will benefit consumers, while the profits of the downstream monopolist may decrease or increase, depending on the size of the market.¹⁹

Fig. 5 combines Figs. 2 and 3 to demonstrate the effect of à la carte on the different consumer groups. We assume, as it is the case in all the simulations, that the sum of the à la carte prices is higher than the bundle price in the PB regime, pₐ + pₙ > pₙ. This is also consistent with what industry experts predict to happen following an à la carte regulation. We have also kept the advertising levels, αₐ and αₙ, fixed. There are five different consumer groups:

18 We have verified this by increasing the mean consumer valuations from 4.5 to 18, while keeping all the other parameter values fixed. In this exercise the marginal valuation is below the mean WTP (mass market) and à la carte lowers profits. More details are available upon request.
19 This is not a new result (see, for example, Schmalensee, 1984), but we present it for completeness.

¹⁷ For example, when ρ = −0.5 the average WTP for the bundle is 4.5 + 4.5 − 2 × 0.938 = 7.124, which is below the price 8.170.
A, B, C, D and E. Total demand under pure bundling consists of: A+B+C+E, while total demand under NB consists of: A+B+C+D. The change in aggregate consumer surplus from PB to NB can be decomposed as follows:

- D: (+). New consumers under NB who subscribe and view one channel. Consumer surplus increases.
- A: (+). Consumers who watch one channel under both regimes but under NB pay a lower price. Consumer surplus increases.
- E: (−). Consumers who used to purchase and view the bundle under PB and drop out of the market in NB. Consumer surplus decreases.
- B: (−). Consumers who subscribe and view the bundle under both regimes but under NB pay a higher price. Consumer surplus decreases.
- C: (?). Consumers who switch from subscribing and viewing the bundle under PB to subscribing to one channel under NB. The overall effect for this group is ambiguous. Some consumers benefit from à la carte (those closer to area B), while others do not.

Consumers with intermediate preferences for both channels (e.g., group B) are more likely to get hurt from à la carte pricing, whereas consumers with high valuations for only one channel (e.g., group A) are more likely to benefit. The overall effect on consumer welfare depends on the mass of these consumer groups (which in turn depends on the distribution of preferences and the correlation coefficient), as well as on the magnitude of the price (which among other things depends on the license fees) and advertising changes from PB to NB. As we have already mentioned, in our simulations the positive effect outweighs the negative. This can be seen by comparing the CS between Tables 1 and 2, for each value of the correlation coefficient $\rho$.

We turn to the advertising and license fee effects next.

### 3.2. Advertising effect

**Definition 3.** The advertising effect is the change in the advertising levels $\alpha$, from PB to NB, holding the license fees $c$ fixed at the PB levels. Also, it is the change in profits and welfare, between NB$_2$, where both $\alpha$ and $c$ are fixed at the PB levels, and NB$_3$ where only $c$ is fixed at the PB level.

The advertising effect is the change in equilibrium values from Table 2 to Table 3. The change in the levels of advertising is attributed to the change from PB to à la carte, given that license fees are fixed. The change in profits and welfare is attributed solely to the effect à la carte has on advertising (since we control for license fees and for the change due to the response of the downstream monopolist). À la carte results in higher levels of advertising when $\rho = -0.5$ and lower levels of advertising when $\rho = 0$ and $\rho = 0.5$. For example, when $\rho = -0.5$, $\alpha$ increases from 0.938 to 0.940, while when $\rho = 0.5$ advertising decreases from 0.920 to 0.890. The advertising effect is negative for profits and consumer welfare when $\rho = -0.5$ and positive when $\rho = 0$ and $\rho = 0.5$. See also Table 5.

The intuition behind the advertising effect is as follows. Given the Cournot-type competition of the two TV channels for advertisers, the equilibrium levels of advertising are higher than what maximizes joint upstream profits. We have verified this by computing that the collusive levels of advertising are indeed lower than what is reported in the PB case of Table 1 (details are omitted). When à la carte leads to lower advertising levels, profits increase since TV channels are able to lower excessive (for their profits) advertising. This is what we observe in Table 3.

There are two opposing effects on advertising levels when the market switches from PB to NB: a location and a slope effect of the inverse advertising demand (3).

We explain how these effects operate, starting from the slope effect. Fix the levels of advertising and the advertising fees at the equilibrium levels under PB. Now allow the monopolist to change to NB, but force the new inverse demand curve to pass through the equilibrium under PB. The inverse demand curve under PB is steeper (locally) than NB. We term this the slope effect. To see this, assume that channel $i$, say CNN, decreases its level of advertising $\alpha_i$. This will have two effects on the advertising fee $g_i$: i) a direct effect and ii) an indirect effect through the number of viewers $q_i$. The direct effect, which is the same in both NB and PB, increases the advertising fee $g_i$, while we hold the number of viewers $q_i$ fixed. The indirect effect has to do with the fact that, in a two-sided model, fewer ads

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20 If we compared Table 3 with Table 1, then the change in profits and welfare would be due to both the change from PB to à la carte and the change in advertising.
Ad level at CNN decreases

DIRECT EFFECT

TV subscription fee increases more in NB than in PB

INDIRECT EFFECT

Viewer WTP increases

Because the cable operator has more freedom to raise the price of CNN in NB (keeping the price of FOX fixed) than the price of the bundle in PB

Ad fee increases the same under NB and PB

Number of viewers decreases more in NB than in PB

Direct effect dominates, so ad fee increases overall

But it increases more in PB because the indirect effect is weaker in PB

So, advertising demand is steeper in PB than in NB

Fig. 6. The slope effect of advertising.

imply lower viewer disutility from advertisements and hence stronger viewer demand for TV networks, i.e., higher \( q_i \) and hence higher advertiser willingness to pay. The indirect effect is stronger in PB than in NB. We can explain this as follows (see also Fig. 6).

With NB, the monopolist operator, in an attempt to appropriate part of the viewers’ higher willingness to pay due to less advertising, will increase the subscription fee of CNN. He will not, however, change the subscription fee of Fox News Channel, because the level of advertising on Fox News has not changed. The strength of the indirect effect is reduced. On the other hand, under PB, the monopolist operator has less freedom in setting his subscription fees. He will be more cautious (compared to NB) in raising the subscription fee, because the bundle is now purchased by all viewers, including those who only like Fox News. As a result, the indirect effect is reduced less in PB than in NB. Putting the direct effect (which is the same in PB and NB) together with the indirect effect of a decrease of CNN’s advertising level, we can conclude that the increase of the advertising fee on CNN is larger under PB than under NB. This implies a steeper slope of the inverse demand function in PB and thus less advertising and a higher fee in PB. The slope effect weakens as the disutility from advertising \( t \) decreases. If \( t \) approaches zero, then there is no difference in the slopes, because the indirect effect disappears \((q_i)\) is no longer a function of \( \alpha_i \) in the inverse advertising demand (3).

For the slope effect we forced the inverse demand curve under PB to pass through the equilibrium point under NB. Now we allow the location to adjust, following a transition from PB to NB, which is the location effect. When \( \alpha \) is fixed, PB attracts more viewers \( q \) (compare the number of viewers between Tables 1 and 2 for each value of \( \rho \)). This implies a higher advertiser willingness to pay \( g_i \) under PB (demand under PB shifts out) and therefore higher levels of advertising. The location effect is stronger the higher the correlation parameter. This is because when \( \rho \) is low most subscribers watch one channel under PB, that is, the mass of the area \( B+C+E \) in Fig. 5 is relatively small. When we move to \( {\text{à la carte}} \) the number of viewers does not decrease much, which weakens the location effect.

To summarize, the slope effect indicates that a switch from PB to NB will raise equilibrium advertising levels, while the location effect indicates that advertising will decrease. The net result depends on the relative strength of these two effects. In the simulations in Table 3 the location effect dominates the slope effect when \( \rho = 0 \) and \( \rho = 0.5 \), while the opposite is true when \( \rho = -0.5 \).

**Result 2 (Advertising effect):** Advertising levels are more likely to decrease (increase) and advertising revenue is more likely to increase (decrease), following an \( {\text{à la carte}} \) regulation (relative to pure bundling), when the correlation of valuations is high (low) and/or the consumer disutility from advertising is low (high). Consumer surplus increases when advertising levels decrease.

### 3.3. License fee effect

**Definition 4.** The license fee effect is the change in license fees \( c \), from PB to NB, holding the advertising levels \( \alpha \) fixed at the PB levels. Also, it is the change in profits and welfare, between NB, where both \( \alpha \) and \( c \) are fixed at the PB levels, and NB where only \( \alpha \) is fixed at the PB level.

The license fee effect is the change in equilibrium values from Table 2 to Table 4. The change in license fees is attributed to the change from PB to \( {\text{à la carte}} \), given that advertising levels are fixed at the PB equilibrium. The change in profits and welfare is attributed solely to the effect \( {\text{à la carte}} \) has on license fees (since we control for
advertising levels and for the change due to the response of the downstream monopolist).

What is the effect of à la carte pricing on the license fees? The answer to this question is important, because license fees affect downstream prices and consumer welfare. Crawford and Yurukoglu (2012) show that an à la carte regulation will increase license fees while Rennhoff and Serfes (2009) show the opposite. Our numerical results try to shed light on this issue. The license fee effect shows that license fees can either increase or decrease, depending on the correlation coefficient. When \( \rho = -0.5 \) à la carte raises the equilibrium license fees from 0.542 to 1.368. Consumer surplus decreases. However, when \( \rho = 0.5 \) license fees are lower in à la carte (1.589 vs. 1.384), while consumer surplus increases.

The intuition is as follows. When the correlation of the valuations is low the inverse demand under pure bundling is relatively flat (elastic). License fees (and final prices) in this case are low and the number of viewers is high. This can be seen by comparing the number of viewers in Table 2 between \( \rho = -0.5 \) where \( q = 0.348 \) and \( \rho = 0.5 \) where \( q = 0.305 \). A license fee reduction when \( q \) is high is more 'costly' to the upstream firms in terms of lost revenue from inframarginal subscribers, and therefore license fees end up rising. On the other hand, when \( q \) is low, as is the case when \( \rho = 0.5 \), upstream firms have stronger incentives to lower their license fees. In developing this intuition we have varied the correlation parameter to affect the size of the market. However, the same effects would arise if we had kept the correlation parameter fixed and varied the average consumer valuation \( \mu \). For instance, by fixing \( \rho \) at \(-0.5\) and increasing \( \mu \) from 4.5 to 18, while keeping all other parameter values fixed, we can show that the license fee decreases, from 7.556 in PB to 6.027 in à la carte (license fee effect).\(^{21}\) In this example, in the status quo case of PB the number of viewers for each channel is \( q = 775 \).

**Result 3 (License fee effect):** License fees are more likely to decrease (increase) following an à la carte regulation relative to pure bundling, when the number of viewers \( q \) is low (high). Higher license fees lower consumer welfare.

Therefore, our analysis offers a more comprehensive view of this important effect in two-sided markets with an upstream–downstream structure than the previous literature, which relied either on a less flexible model (Rennhoff and Serfes (2009)) or on specific parameter estimates (Crawford and Yurukoglu (2012)).

3.4. All three effects combined

The overall change in prices, profits and welfare, due to à la carte pricing (relative to PB) is given in Table 1. However, Table 1 combines all three effects and therefore it is not clear what the driving forces and intuition are behind each effect. In the last three subsections we have isolated each one of the three effects, which are summarized in Table 5 (\( \Delta \) denotes change).

The sorting effect is positive for the downstream firm and consumers and negative for the upstream firms. We have explained why it is positive for the downstream monopolist and consumers in Section 3.1. For the upstream firms it is negative because the license fee revenue decreases since the number of subscribers in à la carte is lower. But also keep in mind that in the sorting effect the upstream firms are passive, since their strategic variables – advertising levels and license fees – are kept fixed.

Recall from Section 3.2 that when the market switches from PB to NB the advertising levels increase when the correlation coefficient is low, while they decrease when the correlation is high. As a result, the advertising effect is positive or negative for the upstream TV channels' profits. When the correlation coefficient is low (\( \rho = -0.5 \)) advertising revenue decreases because the advertising levels increase further from the already high levels. But when the correlation coefficient is high (\( \rho = 0.5 \)) advertising revenue increases because TV channels are able to lower wasteful advertising.\(^{22}\) Consumers benefit if and only if there is less advertising. The downstream operator also benefits if there is less advertising, since that allows it to raise the prices while the number of subscribers also increases. To be clear, the total change in upstream profit, from PB to NB holding license fees fixed, is obtained by

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\(^{21}\) Details are available upon request.

\(^{22}\) This observation is important for the policy discussion we offer at the end of this section.
comparing Table 1 with Table 3, or by combining the sorting and advertising rows in Table 5. In this comparison, \( \pi^T \) is lower in à la carte for all values of \( \rho \). However, this comparison includes the change in profit due to both the change in advertising and due to the change in pricing regime (sorting effect).

Finally, the license fee effect can be either positive or negative for the upstream TV channels for the reasons we explained in Section 3.3. When the license fee effect is positive for the upstream TV channels it is negative for the downstream monopolist and consumers and vice versa. This is not surprising because a higher license fee squeezes the profits of the downstream monopolist and raises the final prices for the viewers.

The decomposition of the total effect of the welfare/profit change from PB to à la carte into the three effects allows us to shed light on the policy debate regarding an à la carte regulation. TV networks usually argue that à la carte will result in loss of advertising revenue (because audiences will decline) that they would want to recoup with higher license fees. Our simulations find mixed support for this argument. First, in general, advertising revenue can either go up or down in à la carte (relative to pure bundling), although audiences will indeed decline. Second, and most importantly, the direction of change of the license fees, in general, does not seem to be related to the change in advertising revenue. From Table 5 we can discern that license fees can either go up or down while the advertising effect is positive. Perhaps, a more relevant comparison for the TV channels’ argument is to look at the change in upstream profit from PB to NB that combines the sorting and the advertising effects. Upstream profits in this case decrease for all values of \( \rho \) (the sorting effect dominates). Nevertheless, the TV channels do not always raise their license fees. When \( \rho = 0.5 \) they actually lower their license fees (Table 1). Therefore, it is not the loss of advertising revenue that can trigger a license fee increase, but rather the underlying specific forces in the market.

4. Conclusion

We conduct a numerical simulation to compute the equilibria of a two-sided market model with an upstream–downstream structure. More specifically, the platform consists of two rival upstream firms and a downstream monopolist. Each upstream firm negotiates with the downstream monopolist the input price (license fee) and also chooses the amount of advertising that is embedded in the good it sells to the downstream monopolist. The downstream monopolist, in turn, can offer the two goods either à la carte or as a pure bundle.

We use this model to understand the welfare implications of bundling in a two-sided market with an upstream–downstream structure. We also contribute to the ongoing debate about à la carte pricing in the TV industry. The upstream firms can be viewed as two TV networks (e.g., CNN and Fox News Channel) and the downstream firms as a monopolist cable operator (e.g., Comcast).

We derive a number of results, but the most interesting and novel ones can be summarized as follows. First, à la carte decreases the advertising levels, relative to pure bundling. Second, we shed more light on the conditions that determine whether à la carte pricing lowers or raises the license fees. In our model both possibilities arise, depending on the size of the market (number of viewers). Finally, we examine the effects of an à la carte regulation. There are three effects that affect welfare: i) sorting effect, ii) advertising effect and iii) license fee effect. Our paper is the first one that models all these three effects, allowing also for correlation of consumer valuations between the two goods. We offer an intuition for each one of the three effects that can be applied more generally in two-sided markets with an upstream–downstream structure.

For the parameter values we chose from the empirical literature on the TV industry, we find that à la carte (relative to pure bundling) will result in higher final prices and lower advertising levels. Despite the higher final prices, consumer surplus increases because viewers can pick and choose the channels they really like and because à la carte entails less advertising. The effect on license fees is ambiguous and it depends on the correlation coefficient. À la carte will also increase the profits of the downstream cable operator, but it will decrease the profits of the upstream TV networks.

In this paper, we have relied on numerical simulation methods to solve our two-sided model. There are a number of limitations inherent in our choice. Without closed-form solutions it is difficult to truly conduct comparative statics, which would allow us to isolate and identify the impact that each model parameter has on equilibrium prices and advertising levels. We have made a modest attempt at conducting comparative statics using different parameter values (and have performed a number of robustness check in the Appendix A), but we acknowledge that the insights we derive may be limited.

Our reliance on time-consuming numerical methods also requires us to make a number of simplifying assumptions. For example, we assume the upstream firms are symmetric. There are a variety of ways in which asymmetry might meaningfully be incorporated into the model (asymmetric value to the advertisers, costs, etc.). Additionally, we have ignored the possibility of downstream competition, which could certainly have additional implications for the profitability of bundling decisions.

Appendix A

A1. Simulation algorithm

We use Matlab to conduct the numerical simulation needed to find the model equilibria. Since it is not possible to derive analytical expressions for the final prices a cable operator will charge for given license fees and advertising levels, we are unable to use first order conditions to find the equilibrium prices. Our inability to rely on first order conditions substantially increases the computation time of our simulation. Instead of simultaneously solving a system of equations for all unknown prices, we must rely on an iterative approach. In our model, the final prices \( p_i \) are determined in a different stage than the stage of setting advertising levels and license fees. Therefore, in each
iterative step, we need to find the optimal prices for the downstream cable operator in response to the changes in either advertising levels or license fees. All minimizations (maximizations) are done using the Nelder–Mead method (Matlab’s fminsearch command). More specifically, we use the iterative approach we describe below to derive the equilibrium values in Tables 1, 3, and 4. Table 3 includes only advertising, so we skip steps 4 and 5 in the estimation, while Table 4 includes only license fees, so steps 2 and 3 are skipped.

The detailed simulation algorithm is summarized as follows:

Step 1: We start by choosing initial values for advertising levels \( \alpha_1^{\text{old}} \) and \( \alpha_2^{\text{old}} \), the license fees \( c_1^{\text{old}} \) and \( c_2^{\text{old}} \), and the final prices set by the cable operator.

Step 2: We fix \( \alpha_2^{\text{old}}, c_1^{\text{old}}, \) and \( c_2^{\text{old}} \) and allow \( \alpha_1 \) to change. The cable operator responds to any change in \( \alpha_1 \) by setting (new) prices \( p_i \) to maximize its profit. Channel 1 will choose its advertising level until its profit is maximized. We rename this new (conditionally optimal) advertising level as \( \alpha_1^{\text{new}} \). Given the values of \( \alpha_2^{\text{old}}, c_1^{\text{old}}, \) and \( c_2^{\text{old}} \), this is assumed to be an optimal best response.

Step 3: There may be multiple equilibria in our model. Given the assumed symmetry in our channels, we focus exclusively on symmetric equilibria. As such, we define \( \alpha_2^{\text{new}} = \alpha_1^{\text{new}} \). In addition to aiding in the identification of our symmetric equilibrium, such an approach helps to dramatically reduce computation time.

We then switch to the determination of license fees:

Step 4: Taking the current advertising values \( \alpha_1^{\text{new}} \) and \( \alpha_2^{\text{new}} \) and the initial value of \( c_2 \) as given, we find the new optimal license fee for channel 1 \( (c_1^{\text{new}}) \) by maximizing the Nash product. Once again, we allow the cable operator to respond to any change in \( c_1 \) by setting new prices to maximize its profit.

Step 5: As we did when considering the determination of advertising levels, we impose symmetry in license fees as well. This implies setting \( c_2^{\text{new}} = c_1^{\text{new}} \).

Steps 2 through 5 are repeated until the changes in \( \alpha_1 \) and \( c_1 \) are smaller than a specified threshold, which is \( 10^{-12} \) for all simulations.

### A2. Robustness checks

The robustness checks we perform in this Section have the goal to make the reader more comfortable that the numerical methods produce general, policy-relevant results. First, in Section A2.1, we run many more simulations with different parameter values in the ‘neighborhood’ of those for the CNN-FOX News simulation of Section 3, to address the issue of ‘continuity’ of the equilibrium variables with respect to the parameters. Second, in Section A2.2, we run another simulation. In this simulation we use parameter values close to those for Disney and Nickelodeon, both of which offer programming that might be appealing to households with younger children. In both cases our main results and intuition continue to be valid.

### A2.1. Simulations based on different parameters values for the CNN-FOX News simulation

We have allowed the mean \( \mu \) and standard deviation \( \sigma \) of consumer valuations to vary as well as the bargaining parameter \( \lambda \), while all the other parameters, i.e., \( n, t, k_1, k_2 \) and \( k_3 \), have been kept fixed (see Section 3). Each simulation is based on a random draw of a \( (\mu, \sigma, \lambda) \) vector of parameter values, where each coordinate of the vector is drawn from an interval with uniform distribution.
We allow $\mu$ to be uniform in the interval $(4, 5)$, we allow $\sigma$ to be uniform in the interval $(5, 6)$, and we allow $\lambda$ to be uniform in the interval $(0.3, 0.6)$. We believe that these intervals provide sufficient coverage of the ‘neighborhood’ around our chosen parameter values. We obtained 50 draws (and so we run 50 simulations) for each correlation value ($\rho = -0.5, 0, 0.5$). To make the results more presentable, we draw graphs depicting the three main equilibrium variables, that is, advertising level $\alpha$, license fee $c$ and downstream prices $p$. A graph plots two of the three variables, and so we created three graphs (($p, \alpha$)– see Fig. 7, ($c, \alpha$)– see Fig. 8 and ($p, c$)– see Fig. 9).
Table 6
Two-sided market with advertising and license fees.

<table>
<thead>
<tr>
<th>ρ</th>
<th>p</th>
<th>p_B</th>
<th>α</th>
<th>c</th>
<th>q/D</th>
<th>π^D</th>
<th>π^U</th>
<th>CS</th>
<th>TS</th>
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<td>-</td>
<td>0.448</td>
<td>0.877</td>
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<td>0.884</td>
<td>0.444</td>
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<td>0.000</td>
<td>0.368</td>
<td>0.506</td>
<td>0.769</td>
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<td>0.877</td>
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<td>PB</td>
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<td>0.453</td>
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<td>0.793</td>
<td>0.387</td>
<td>0.629</td>
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<td></td>
<td>0.5</td>
<td>5.005</td>
<td>0.465</td>
<td>0.833</td>
<td>0.235</td>
<td>0.237</td>
<td>0.781</td>
<td>0.439</td>
<td>0.596</td>
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Table 7
Advertising and license fees fixed at the PB equilibrium.

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<th>ρ</th>
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<th>α</th>
<th>c</th>
<th>q</th>
<th>π^D</th>
<th>π^U</th>
<th>CS</th>
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<td>0.250</td>
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<td>3.064</td>
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<td>0.453</td>
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<td>1.084</td>
<td>0.366</td>
<td>0.814</td>
</tr>
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<td></td>
<td>0.5</td>
<td>2.744</td>
<td>0.465</td>
<td>0.833</td>
<td>0.235</td>
<td>0.896</td>
<td>0.436</td>
<td>0.686</td>
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</table>

Table 8
License fees fixed at the PB equilibrium.

<table>
<thead>
<tr>
<th>ρ</th>
<th>p</th>
<th>α</th>
<th>c</th>
<th>q</th>
<th>π^D</th>
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Table 9
Advertising levels fixed at the PB equilibrium.

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<th>α</th>
<th>c</th>
<th>q</th>
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<th>π^U</th>
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Table 10
All three effects combined.

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<th>ΔCS</th>
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<td>−0.5</td>
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<td>−0.003</td>
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</tbody>
</table>

Each point on a graph refers to a different simulation, and so there are 50 points for each correlation value (three correlation values for the PB case: −0.5, 0 and 0.5 and the NB bundling case). The main purpose of these graphs, and the simulations we run, is to demonstrate that equilibrium values change 'smoothly' with parameters and that there are no unreasonable spikes or troughs in the graphs. Therefore, the intuition behind the main results, and the three effects in particular, will continue to hold, at least for numerical values in the 'neighborhood' of those reported in the main simulation in the paper.

A2.2. Disney and Nickelodeon
For this simulation, we chose μ = 1.4, σ = 2.5 and λ = 0.38. Moreover, we ‘calibrated’ n, t, κ_1, κ_2 and κ_3 so that the equilibrium license fees from our simulations come close to those reported in Crawford and Yurukoglu. When ρ = 0.5 (a positive correlation of consumer valuations is a reasonable assumption for these two channels) the equilibrium license fee under PB we derive from our simulation is 0.833.24 The results from our simulations are qualitatively similar to the ones we report in the main text in the paper. Table 6 presents the total effect, while Tables 7–9 present the three effects: sorting, advertising and license fee. Finally, Table 10 summarizes the three effects for profits and consumer welfare.

As we can see from Table 10 all effects are qualitatively the same with the corresponding effects from our main simulation (see Table 5), except for the license fee effect when ρ = 0.5 in which case the sign of the effect

23 The reported values in Crawford and Yurukoglu for these two channels are as follows: Disney: μ = 1.43, σ = 2.51 (Table 4 in Crawford and Yurukoglu) and λ = 0.28 (assuming a big cable operator, see Table 7 in Crawford and Yurukoglu) and Nickelodeon: μ = 1.31, σ = 2.55 (Table 4 in Crawford and Yurukoglu) and λ = 0.49 (assuming a big cable operator, see Table 7 in Crawford and Yurukoglu).

24 In Crawford and Yurukoglu the reported license fees under PB are 0.77 for Disney and 0.48 for Nickelodeon (see Table 9 in their paper). We could not get our license fee closer to those reported in Crawford and Yurukoglu (when ρ = 0.5) because when ρ = −0.5 our license fee is very close to zero. Any further reduction of the license fees would force us to deal with corner solutions in the simulation.
flips. Nevertheless, the intuition for this comparison follows the one behind Result 3 in Section 3.3. The license fee increases for all three correlation values we considered because the number of viewers $q$ is low due to the low $\mu$ we have assumed.

References