Essays on Bundling and A La Carte Pricing in a Two-Sided Model

A Thesis
Submitted to the Faculty
of
Drexel University
by
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in partial fulfillment of the requirements for the degree of
Doctor of Philosophy
June 2010
Dedications

To my loved family
to whom I owe lifetime gratitude
Acknowledgements

I would like to thank the members in my committee: Konstantinos Serfes Ph.D. (chair), Constantinos Syropoulos Ph.D., Teresa Harrison Ph.D., Mian Dai Ph.D., and Adam Rennhoff Ph.D.. I would not have finished my pursuit for doctorate without their unselfish support and encouragement. I would like to give special thanks to Dr. Konstantinos Serfes for his supervision and advice on the process of my study and research. Not only instrumental for this thesis, his academic guidance is also continuously valuable for my research in the future. His enthusiasm and creativity in research is always the academic model that I will be after.

I appreciate greatly for all professors who once taught me in the Ph.D. program. I learned a lot from them, inside and outside the classrooms. What they gave me is the fundamental but indispensable assets as an economist. I feel so fortunate that I once sit in their classroom and listened to them.

I cannot find any language to thank all my family who support me during the years that I am far away from them, especially my parents. I owe them too much as their daughter.
# Table of Contents

LIST OF TABLES ................................................................................................................................... vii

LIST OF FIGURES ................................................................................................................................. viii

ABSTRACT ........................................................................................................................................... ix

1. Bundling and A La Carte Pricing in a Two-Sided Model ............................................................... 1
   1.1 Introduction ................................................................................................................................. 1
       1.1.1 Literature Review ................................................................................................................ 4
   1.2 The model ................................................................................................................................. 5
       1.2.1 TV Networks ........................................................................................................................ 6
       1.2.2 Monopolist cable operator .................................................................................................. 6
       1.2.3 Viewers (consumers) .......................................................................................................... 6
       1.2.4 Advertisers ........................................................................................................................ 7
   1.3 Benchmark: Equilibrium in a one-sided model (no advertising) ............................................... 8
   1.4 Analysis of the main two-sided model ...................................................................................... 10
       1.4.1 Discussion of the Equilibrium ............................................................................................ 11
       1.4.2 Consumer surplus when bundle is allowed ....................................................................... 15
   1.5 A la carte pricing (bundling is not allowed) ............................................................................ 16
       1.5.1 Profit comparisons with and without regulation ............................................................... 16
       1.5.2 Number of viewers comparison ....................................................................................... 17
       1.5.3 Advertisement level Comparison ...................................................................................... 17
       1.5.4 Welfare Comparison ......................................................................................................... 18
   1.6 Robustness checks .................................................................................................................... 19
       1.6.1 The effects of substitution (complementary) .................................................................... 19
       1.6.2 Effects of marginal cost ...................................................................................................... 20
   1.7 Conclusion ................................................................................................................................ 21

2. Bundling, A La Carte Pricing and Vertical Bargaining in a Two-Sided Model: An
   Numerical Approach ...................................................................................................................... 23
   2.1 Introduction ............................................................................................................................... 23
List of Tables

B.1 No upstream firm, $\mu_i = 30$ (big market) ............................................... 85
B.2 No upstream firm, $\mu_i = 10$ (small market) ............................................. 86
B.3 With advertisement, $\mu_i = 30, t&n = 1$ .................................................. 86
B.4 With advertisement, $\mu_i = 30, t&n = 10$ ............................................. 87
B.5 With license fee, $\mu_i = 30$ .................................................................. 87
B.6 With license fee, $\mu_i = 15$ .................................................................. 87
B.7 Comparison of elasticity under no bundling when license fee is fixed at the level of pure bundling ................................................................. 88
B.8 With advertisement and license fee, $\mu_i = 30, t&n = 1$ .......................... 88
B.9 With advertisement and license fee, $\mu_i = 30, t&n = 5$ .......................... 89
B.10 With advertisement and license fee, $\mu_i = 30, t = 1, n = 5$ ................. 89
B.11 With advertisement and license fee, $\mu_i = 30, t = 3, n = 1$ ................. 90
B.12 Welfare comparison (no upstream) ............................................................ 90
B.13 Welfare comparison (with ad), $t&n = 1$ .................................................. 91
B.14 Welfare comparison (with ad), $t&n = 10$ ............................................ 91
B.15 Welfare comparison (with ad and license fee), $t&n = 1$ ....................... 92
B.16 Welfare comparison (with ad and license fee), $t&n = 5$ ....................... 92
B.17 Sample statistics: television programming service data ....................... 93
B.18 Sample statistics: rating .......................................................................... 94
B.19 Sample statistics: advertisement data .................................................... 95
B.20 Non-random utility parameter estimates ................................................. 97
B.21 Median of the maximum own advertisement elasticity of audience size .... 100
B.22 Cable service subscription parameter estimates ...................................... 101
B.23 Inverse demand for ads. parameter estimates ........................................ 102
B.24 License fees ............................................................................................. 104
B.25 Marginal costs .......................................................................................... 104
List of Figures

C.1 Description of Model ................................................................. 105
C.2 Subscription Fees in the Equilibria ............................................. 106
C.3 Number of Viewers in the Equilibria ......................................... 106
C.4 Advertising Fees in the Equilibria ............................................. 107
C.5 Advertising Levels in the Equilibria ........................................... 107
C.6 Consumer Surplus in the Equilibria ......................................... 108
C.7 Number of Viewers Comparison ............................................... 108
C.8 Ads Levels Comparison ............................................................ 109
C.9 Consumer Surplus Comparison .................................................. 109
C.10 Bundle Flattens Demand ......................................................... 110
C.11 Demand under No Bundling ...................................................... 110
C.12 Demand under Pure Bundling .................................................. 111
C.13 Demand under Mixed Bundling ............................................... 111
C.14 Demand under NB when c is fixed at the Level of PB ................. 112
Abstract
Essays on Bundling and A La Carte Pricing in a Two-Sided Model

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My dissertation examines the profitability of bundling and the impact of an a la carte regulation in a two-sided market. This is primarily motivated by the ongoing debate about whether TV cable operators should be forced to offer TV channels on an a la carte basis, as opposed to the current practice where only big bundles of channels are available for viewers. My main contribution is that I formally incorporate the advertising side and I view each TV network as a two-sided platform that wants to attract viewers and advertiser. The first essay is theoretical, the second numerical and the third empirical.

In the first essay, I construct a theoretical model to analyze the incentive of a monopolist cable operator to bundle his products. The cable operator chooses how to offer the TV channels to viewers: he can offer them separately (a la carte), together in a bundle (pure bundling), or a combination of the two (mixed bundling). In a one-sided market, the conventional finding is that mixed bundling is the weakly dominant strategy for a seller. However, this may not hold in a two-sided market where the interplay between the two sides (viewers and advertisers) creates new effects. In particular, mixed bundling can generate higher levels of advertising, which hurts viewer and the profits of a monopolist and pure bundling can strictly dominate mixed. Under a la carte pricing, the TV channels will lower the advertising fees so that the advertising levels will be higher than under pure bundling. All else equal, this makes viewers worse off but the monopolistic cable operator better off. However, the cable operator will react by lowering the subscription fees, partially offsetting the negative impact of advertising.

In the second essay, I conduct a numerical simulation by relaxing two assumptions made in the first essay. First, viewer willingness to pay for the channels follows a bivariate normal distribution. Second, the license fees are endogenously negotiated and determined by these
two parties via Nash bargaining. I numerically simulate the equilibria of no bundling, mixed bundling and pure bundling. I find that bundling flattens viewers’ demand, and enables the monopolistic cable operator to extract more surplus from consumers. If the upstream network and downstream cable operator are allowed to bilaterally negotiate the license fee, license fees will be higher (lower) under pure bundling depending on whether cable operator has mass (niche) market demand. Advertisement plays a very important role, by incorporating advertisement in our model, it is possible that pure bundling strictly dominates mixed bundling.

In the third essay, I empirically estimate the viewers’ preference parameters, which give us viewers’ dollar valuation for individual channels. I set up a structural model to test the impact of an a la carte regulation in the cable TV industry. I formally model household decision (regarding television-watching and cable package choices), cable operator pricing decisions and television channel advertisement pricing decisions. In the estimation of household television-watching decision, I explicitly incorporate advertising in the utility function and find that advertising levels bring negative utility to most of the consumers. I also estimate the inverse demand for advertising on TV channels. Finally, I conduct a counterfactual simulation to examine how an a la carte regulation will affect the industry.
1. Bundling and A La Carte Pricing in a Two-Sided Model

1.1 Introduction

We investigate a monopolist’s incentives to bundle his products and the welfare implications of an a la carte regulation in a two-sided market environment. Our paper is motivated by the ongoing debate about whether the government (Federal Communications Commission, FCC) should regulate the TV industry and force cable and satellite operators to offer channels a la carte. The TV industry is a typical two-sided market.\footnote{Examples of other two-sided markets can be found in Rochet and Tirole (2003)}.

The TV networks target two different groups of agents simultaneously: advertisers and viewers. The higher the number of viewers a TV network has, the more attractive this network is to advertisers. In contrast, advertisements impose a negative externality on viewers, because they distract viewers from watching programs. A standard result in the bundling literature in one-sided markets is that mixed bundling is a weakly dominant strategy for a monopolist. We show that this may no longer be true in a two-sided market, as pure bundling can strictly dominate mixed bundling. The reason is that the amount of advertising on each channel depends on how the monopolist offers his products. Pure bundling results in less advertising which makes consumers better off and allows the monopolist to increase his profits (relative to mixed bundling). This may explain why pure bundling is the predominant method cable operators use to package TV channels, a prediction that a one-sided model cannot deliver.

Moreover, and since mixed bundling can be used to sort consumers and extract more surplus, an a la carte regulation benefits consumers in a one-sided market environment. However, in a two-sided market model consumers may be worse off following an a la carte regulation, because the level of advertising may increase.

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 improve-
ments. 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. By contrast, cable interest groups oppose the idea of a la carte pricing. They argue that bundling lowers transaction costs, realizes economies of scale and simplifies consumers’ decision-making process, and a la carte pricing will hurt consumers by driving up prices. The attitude of the FCC about a la carte pricing is ambiguous. The FCC has published two reports on a la carte pricing. In the November 2004 report, they concluded that a la carte pricing would result in higher prices and thus provide little benefit to consumers. However, in the February 2006 report, their conclusion is the opposite from the previous one.

The model we develop can be used to inform policy makers about the welfare properties of a la carte pricing in the TV industry. Our contribution is that we formally incorporate the advertising side and we investigate the impact of advertising on the incentives to bundle and the welfare implications of an a la carte regulation (more details about how our paper is positioned in the literature are offered in the literature review section). This yields new and interesting insights.

More specifically, our model consists of two upstream TV networks and a downstream monopoly cable operator. The TV networks compete via advertising fees to attract advertisers, and sell their contents to the downstream monopolist. The monopolist chooses how to offer the TV channels to viewers. He can offer the TV channels separately (a la carte), together in a bundle (pure bundling) or the combination of the two (mixed bundling). Viewers dislike advertisements but advertisers benefit if the number of viewers on a TV channel is higher. The monopolist, by committing to offering the TV channels as a pure bundle before the TV networks compete for advertisers, is able to influence the demand functions for advertising the TV networks are facing. In particular, competition between the two TV networks for advertisers softens under pure bundling, resulting in higher advertising fees and

\footnote{In the literature on the bundling, a number of papers allow firms to commit to a particular bundling strategy prior to their choices of actual prices, e.g. Matutes and Regibeau (1988) and Economides (1989). In this paper, the stage of cable operator to commit to the bundle strategy before TV networks set the advertisement fees is very important. Without this stage and taking the advertising levels as given, mixed bundling is always a weakly dominant strategy for the monopolist cable operator.}
less advertising.

This works as follows. There are two opposing effects on the (inverse) demand curve for advertising when the downstream monopolist switches from mixed bundling to pure bundling: i) a slope effect and ii) a location effect. The slope effect refers to the fact that the demand curve becomes steeper (less elastic), which implies higher equilibrium advertising fees and less advertising. The location effect refers to the demand curve shifting out, which implies more advertising. The slope effect dominates the location effect in our model and as a consequence the amount of advertising is less under pure bundling than under mixed bundling. This increases the viewers’ willingness to pay and consequently increases the profitability of pure bundling for the monopolist, relative to mixed bundling.

To better understand the slope effect, suppose that the amount of advertising on one channel, say ESPN, decreases. Viewers of ESPN are now willing to pay more and the monopolist responds by raising his subscription fees. The key idea is that the monopolist, due to the lack of pricing flexibility when he only offers the bundle, is more ‘cautious’ in raising his subscription fee to consumers (viewers) under pure bundling. After all, the bundle is also purchased by people who do not watch ESPN and therefore have received no benefit from the reduction in the amount of advertising. Being more cautious implies that fewer viewers are lost when the monopolist raises his subscription fee under pure bundling than under mixed bundling, which in turn implies stronger demand for advertising slots (because there are more viewers). Hence, a TV channel loses fewer advertisers if it unilaterally raises its advertising fee under pure bundling than under mixed bundling and that is why the slope of the demand curve is steeper. (An intuition for the location effect and further discussion on these two effects are offered in section 1.4.1).

The implication of advertising for an a la carte regulation is important. As we mentioned above, an a la carte regulation intensifies the competition among TV networks for advertisers and lowers the advertising fees which implies more advertisements than under pure bundling. All else equal, this will make viewers worse off. However, the monopolist will react by lowering the subscription fees, partially offsetting the negative impact of advertising.
Our results show that an a la carte regulation makes the cable operator worse off. This finding is consistent with the fact that most cable operators are opposing such regulation. The effect of a la carte pricing on consumer surplus is ambiguous. When the unregulated equilibrium is characterized by mixed bundling, viewers become better off from an a la carte regulation. Nevertheless, if the unregulated equilibrium is pure bundling, consumers can be either better off or worse off.

Our model is not specific to the TV industry and it can be applied to other markets that have similar features, e.g., newspapers, credit cards etc. The negative externality one side (advertisers) imposes on the other (viewers) is not crucial for our results. Our main insights continue to hold even when we assume positive externalities on both sides. One of our paper’s main points is that the interaction between the two sides affects the profitability of bundling by influencing the amount of advertising. Basically, pure bundling helps to reduce the amount of the negative externality. In a model with positive externalities on both sides (e.g., newspapers where ads are beneficial to the readers, such as coupons, job listings etc.) pure bundling increases the amount of the positive externality, i.e., more advertising in that setting, making the monopolist better off.

1.1.1 Literature review

Broadly speaking, our paper is related to three different strands of literature: i) bundling, ii) two-sided markets and iii) a la carte pricing.

Firstly, the bundling literature has been traditionally developed under the one-sided market framework. While this is the obvious first step, the predictions of the existing literature cannot be extended straightforwardly to two-sided models\(^3\). Bundling reduces the heterogeneity of consumer valuations and it is a useful tool of price discrimination. Under a monopoly setting, pure bundling and no bundling can be considered as two special cases of mixed bundling. Schmalensee (1984) and McAfee et al. (1989) show that mixed bundling is a weakly dominant strategy, while as we show this is not necessarily true in a two-sided market.

\(^3\)Stole (2007) and Kobayashi (2005) offer excellent surveys of the bundling literature.
Secondly, two-sided markets have recently attracted significant attention. In a two-sided market, platforms compete to attract agents from different groups (e.g., Caillaud and Julien (2003) and Armstrong (2006)). A main goal is to show how the composition of the aggregate price affects the volume of trade (Rochet and Tirole (2006)). Choi (2006) shows that tying can be welfare enhancing in a two-sided market where multihoming is allowed. Anderson and Coate (2005) models media advertising market as a two-sided market, where the number of viewers has a positive externality to advertising level, but viewers dislike advertisement because it shortens the time for the content of the program. Nevertheless, to the best of our knowledge, no paper has examined the profitability of bundling and the a la carte implications in a two-sided framework.

Finally, there is some theoretical and empirical work that tries to evaluate the consequences of an a la carte regulation. On a theoretical level, Rennhoff and Serfes (2009) investigate the incentives to bundle and the a la carte implications in an upstream-downstream oligopolistic framework. Crawford and Cullen (2007), by conducting a numerical analysis, predict that consumers can benefit from a la carte pricing. However, in those papers the advertising side is not modeled. On an empirical level there are the papers by Crawford and Yurukoglu (2008), Dmitri (2008) and Rennhoff and Serfes (2008) who address the issue of a la carte pricing in the TV cable industry.

The remainder of the paper is organized as follows. The main model is presented in section 1.2. A benchmark one-sided model is presented in section 1.3. The main analysis of the two-sided model is provided in section 1.4. The a la carte scenario is analyzed in section 1.5. Some robustness checks are performed in section 1.6. We conclude in section 1.7. All proofs are in the appendix.

1.2 The model

Our model features four types of players (see also figure C.1): viewers, a monopolist downstream cable operator, two competing upstream TV networks (platforms), and adver-
tisers. Below, we explain the role of each group of players in more detail.

1.2.1 TV Networks

There are two TV stations (networks) indexed by a and b, such as CNN and ESPN. Each network can be viewed as a platform that has to attract both viewers and advertisers. On the one hand, networks sell their programs to the cable operator by charging a license fee. On the other hand, they sell advertising slots to the advertisers. Therefore, their profits are composed of two parts: the license fee from the cable operator and the profit from advertisement. For simplification, and in order to better focus on the effect of advertising, we assume that the license fee is equal to zero.

1.2.2 Monopolist cable operator

There is a monopolist cable operator, taking Comcast as an example, which buys the programs from the networks and sells them to the viewers. If there is no a la carte regulation, the cable operator can choose to offer the two channels in one of the following three different ways: i) each channel is offered separately at one stand-alone price, \( p_a \) and \( p_b \) (defined as "no bundling" NB strategy), ii) the two channels are offered separately and together as a bundle with the bundle price \( p_B \) being lower than the sum of the two stand-alone prices (defined as "mixed bundling" MB strategy) and iii) both channels are offered together as a bundle (defined as "pure bundling" PB strategy).

1.2.3 Viewers (consumers)

There are three types of viewers: those with demands only for one channel, either a or b and those with demands for both channels. Type a and type b viewers are called single demand viewers, and type B viewers are the multiple (double) demand viewers. For example, households with many members can be viewed as multiple demand viewers, while smaller households can be viewed as single demand viewers. Type a viewers’ best choice is channel a when the stand-alone price for a is available. Similarly, type b viewers’ best choice
is network b. There is a continuum of viewers in each group. The maximum willingness to pay of the single demand viewers is uniformly distributed in [0,1] and that of the multiple demand viewers is uniformly distributed in [0,\(V\)], with \(V = 2\).

Viewers purchase TV networks from the cable operator where the programs are accompanied with advertisements. We assume that viewers are advertisement adverse, or in other words, advertisements impose a negative utility on viewers.\(^4\). Let \(t\) represent the per-unit nuisance cost of advertisements impose and \(\alpha_i\) denote the amount of advertising on channel \(i\), \(i = a, b\). Viewers will subscribe to their favorite network(s) as far as their net utility is non-negative.

Therefore, the demand functions of each group are given as follows

\[
d_a = 1 - t\alpha_a - p_a
\]

\[
d_b = 1 - t\alpha_b - p_b
\]

\[
d_B = V - t(\alpha_a + \alpha_b) - p_B.
\]

When the cable operator offers only the bundle, then the single demand viewers purchase the bundle, pay the bundle price \(p_B\) and watch only their favorite channel, as long as their net utility is nonnegative. Therefore, the advertisements on the other network will not generate any nuisance cost to them. Multiple demand viewers will form the bundle by themselves if the bundle is not available.

**1.2.4 Advertisers**

We assume that platforms produce TV programs accompanied with certain amount of advertisements. We assume that there is a continuum of advertisers with different willingnesses to pay. Moreover, advertisers are willing to pay a higher advertisement fee \(g_i\) if network \(i\) has attracted more viewers. We denote by \(D_i = d_i + d_B, \ i = a, b\) the aggregate number of viewers channel \(i\) has attracted. Note here that our implicit assumption is that

\(^4\) Wilbur (2008) empirically found that television advertising will cause audience losses. Based on his empirical test, 10% decrease in advertising level will increase audience size by 25%
advertisers value single demand viewers the same as multiple demand viewers. The total number of viewers on a channel depends on the amount of advertising on both channels, \( D_i(\alpha_a, \alpha_b) \). This is because \( \alpha_b \), for instance, affects the number of multiple demand viewers which in turn affects the number of viewers on channel a. Therefore, the aggregate (inverse) demand functions of advertisers are given by

\[
\alpha_a = D_a(\alpha_a, \alpha_b) - g_a
\]

\[
\alpha_b = D_b(\alpha_a, \alpha_b) - g_b
\]

An increase in the advertising fee, say \( g_a \), impacts \( \alpha_a \) directly and indirectly through \( D_a(\alpha_a, \alpha_b) \). The direct effect is obvious. Let’s elaborate a bit more on the indirect effect. If \( \alpha_a \) falls the number of people who watch channel a will also be affected, which in turn affects the demand for advertising slots.

We will analyze the following three-stage game.

- **Stage 1:** The cable operator announces what package he will offer, i.e., pure bundle, mixed bundle or no bundle.
- **Stage 2:** The TV networks simultaneously choose advertisement fees, \( g_a \) and \( g_b \).
- **Stage 3:** The cable operator sets prices, \( p_i \).

We will search for a subgame perfect Nash equilibrium.

### 1.3 Benchmark: equilibrium in a one-sided model (no advertising)

In order to better evaluate the impact of advertising on the monopolist’s incentives to bundle and on the welfare implications of an a la carte regulation, we first find the equilibrium in a one-sided model with no advertising. The proposition below summarizes the result.

**Proposition 1.** The downstream monopolist’s optimal strategy is to offer the mixed bundle
(MB). The subscription fees are given by

\[ p_{OB}^{OMB} = \frac{V}{2}, p_a^{OMB} = \frac{1}{2}, \text{ and } p_b^{OMB} = \frac{1}{2}. \]

The monopolist’s profit is given by

\[ p^{OMB} = \frac{V^2}{4} + \frac{1}{2}. \]

The above result is consistent with the literature on bundling where mixed bundling is a weakly dominant strategy for a monopolist, e.g., Schmalensee (1984) and McAfee, et.al (1989). By offering the mixed bundle the monopolist is able to sort the viewers and price discriminate. The viewers with multiple demands pay a lower per-channel price than the price the viewers with single demand pay. Not surprisingly, this flexibility boosts the monopolist’s profit. The consumer (viewer) surplus is given by

\[ CS^{OMB} = \frac{V^2}{8} + \frac{1}{4}. \]

Let’s now consider an a la carte regulation that forces the monopolist to break the bundle and charge two stand-alone prices, no bundling NB. The cable operator serves all three groups of viewers, with the equilibrium prices given by

\[ p_a^{ONB} = p_b^{ONB} = \frac{V}{6} + \frac{1}{6}. \]

The consumer surplus under an a la carte regulation is

\[ CS^{ONB} = \frac{V^2}{4} - \frac{V}{2} + \frac{3}{4}. \]

It can be easily calculated that \( CS^{OMB} - CS^{ONB} = -\frac{(V-2)^2}{8} \), suggesting that such a regulation enhances consumer welfare. Under mixed bundling, the monopolist can afford to charge relatively high prices to the single demand viewers and offer a discount to the
multiple demand viewers. However, under an a la carte regulation this strategy is no longer viable. In order to attract more multiple demand viewers the monopolist lowers all prices, benefiting the viewers (on average).

1.4 Analysis of the main two-sided model

We now analyze the two-sided model. The next proposition summarizes the SPNE of this game when the viewer disutility from advertising is not too high, i.e., $t=2.3$.

**Proposition 2.** (Bundling is allowed). There are two types of equilibria: a pure bundling $PB$ equilibrium and a mixed bundling $MB$ equilibrium that are described as follows.

- **Pure Bundling (PB).** If $0 \leq V \leq V_1$, the cable operator offers only the bundle. Subscription fees and the cable operator’s profits are given by

  \[
  p_{PB}^B = \frac{18t^2 + t^2V + 30t + 9tV + 6V + 12}{2(5t + 3)(6 + 7t)} \\
  \pi_{PB}^B = \frac{3(18t^3 + t^2V + 30t + 9tV + 6V + 12)^2}{4(5t + 3)^2(6 + 7t)^2}.
  \]

  Advertisement levels and TV networks’ profits are given by,

  \[
  \alpha_a^PB = \alpha_b^PB = \frac{(2V + 1)(4t + 3)}{(5t + 3)(6 + 7t)} \\
  \varphi_a^PB = \varphi_b^PB = \frac{(2V + 1)^2(t + 1)(4t + 3)}{(5t + 3)(6 + 7t)^2}.
  \]

- **Mixed Bundling (MB).** If $V_1 < V = 2$, the cable operator offers the mixed bundle.

---

$^2$2.3 is the necessary condition for the existence of MB equilibrium.

$^6$Where $V_1$ is given by

\[
V_1 = 294330t^2 + 697440t^3 + 69120t + 904204t^2 + 495367t^6 + 151782t^7 + 20091t^8 + 1005836t^4 + 6912.
\]
Subscription fees and the cable operator’s profits in this sub-game are given by,

\[
p_{MB} = \frac{5t^2V - 4t^2 + 14tV - 4t + 8V}{2(3t + 2)(3t + 4)}
\]

\[
p_{a}^{MB} = p_{b}^{MB} = \frac{-(7t^2 + 2t^2V - 16t + 2tV - 8)}{2(3t + 2)(3t + 4)}
\]

\[
\pi^{MB} = \frac{1}{4(3t + 2)^2(3t + 4)^2} (114t^4 + 33t^4V^2 - 96t^4V - 336t^3V + 156t^3V^2 + 480t^3 + 284t^2V^2 + 752t^2 - 368t^2V - 128tV + 224tV^2 + 512t + 128 + 64V^2).
\]

Advertisement levels and TV networks’ profits are given by,

\[
\alpha_{a}^{MB} = \alpha_{b}^{MB} = \frac{(2(1 + t)(1 + V)}{(3t + 2)(3t + 4)}
\]

\[
\varphi_{a}^{MB} = \varphi_{b}^{MB} = \frac{(t + 2)(1 + V)^2(1 + t)}{(3t + 2)(3t + 4)^2}.
\]

### 1.4.1 Discussion of the equilibrium

The most interesting result in Proposition 2 is that, contrary to the prediction from a one-sided model, pure bundling can strictly dominate mixed bundling for the downstream monopolist. This happens when the maximum willingness to pay of the multiple demand group \(V\) is not too high, i.e., \(V = V_1\). There are two effects associated with the monopolist’s decision about how to offer the two products (channels): A pricing effect and an advertising effect. The pricing effect refers to the monopolist’s ability to use the product offerings as a way to extract more surplus from the consumers. In particular, as we have discussed above, mixed bundling sorts viewers according to their preferences and hence enhances the monopolist’s profits. The advertising effect emerges from the two-sided nature of the market and it refers to how the amount of advertising on each channel is affected by the product offerings. As we will discuss in more detail later, mixed bundling attracts more advertisers, in equilibrium, than pure bundling. This lowers the viewers’ willingness to pay for the
mixed bundle and consequently the monopolist’s profits. Therefore, when the advertising effect is stronger than the pricing effect, pure bundling is the strictly dominant strategy for the monopolist.

**Viewer side**

In the pure bundling equilibrium, the price increases as $V$ increases. In the mixed bundling equilibrium, the price of the bundle increases as $V$ increases, while the stand-alone prices are decreasing in $V$. In contrast, in a one-sided market the equilibrium stand-alone prices do not depend on $V$ see Proposition 1. This can be understood as follows. When $V$ increases, more multiple demand viewers purchase the bundle. This attracts more advertisers and the level of advertising increases on both channels, which in turn imposes a disutility on the small demand viewers who are now willing to pay less.

≺ figure C.2 ⊵

The number of viewers the cable operator will serve in each group is shown in figure C.2. We can see that in both equilibria, the viewers in the multiple demand group increase as the maximum-willingness-to-pay increases, while the viewers in single demand groups decreases. In the PB case, when $V$ increases, the cable operator will set a higher price which will reduce the quantity demanded in the single demand groups. In the MB case, the maximum-willingness-to-pay of the multiple demand group viewers can affect the demand of the single demand groups viewers even though the cable operator price discriminates and charges different prices among the three groups. It is because of the cross-group externality, as we have argued above. The cable operator serves more viewers in the multiple demand group but fewer in the single demand group, relative to the PB case.

≺ figure C.3 ⊵

**Advertising side**

In both equilibria, the advertising levels are increasing as $V$ increases. The advertising level jumps up when we move from PB to MB equilibrium. This result is associated with the
positive externality of viewers to advertisers and the negative externality of advertisements to viewers. Let $D_a$ represent the total number of viewers network a has in the equilibrium, and $D_a$ is a function of $a_a$ and $a_b$.

$$D_a^{MB} = d_a^{MB} + d_B^{MB} = \frac{1}{2} + \frac{V}{2} - t\alpha_a^{MB} - \frac{t\alpha_b^{MB}}{2}$$ (1.1)

$$D_a^{PB} = d_a^{PB} + d_B^{PB} = \frac{1}{3} + \frac{2V}{3} - \frac{4t\alpha_a^{PB}}{3} - \frac{t\alpha_b^{PB}}{3}.$$ (1.2)

We have assumed that the demand function for advertising is $\alpha_i = D_i(\alpha_i, \alpha_j) - g_i$. After substituting $D_i$, we know that in the equilibrium the demand functions of advertising are functions of $g_a$ and $g_b$.

$$\alpha_a = D_a(\alpha_a(g_a, g_b), \alpha_b(g_a, g_b)) - g_a$$ (1.3)

$$\alpha_b = D_b(\alpha_a(g_a, g_b), \alpha_b(g_a, g_b)) - g_b.$$ (1.4)

We solve the system of equations represented by equations (1.3) and (1.4) with respect to $g_a$ and $g_b$ in order to derive the demand functions for advertising explicitly. These are given in equations (A.3) and (A.3.2) in the Appendix. We can verify that the inverse demand curves are steeper in the PB subgame than in the MB subgame. This implies higher equilibrium advertising fees and less advertising in PB than in MB. The intuition is as follows. Fix the levels of advertising and the advertising fees at the equilibrium levels under MB. Now allow the monopolist to change to PB, but force the new inverse demand curves to pass through the equilibrium under MB. The inverse demand curves under PB are steeper. We term this the slope effect. As an example, suppose that the two TV networks are CNN and ESPN. Assume that ESPN increases its advertising fee. This will have two effects on the level of advertising: i) a direct effect and ii) an indirect effect. The direct effect, which is the same in both MB and PB, reduces the quantity demanded for advertising (negative effect). Consequently, there will be fewer ads on ESPN. The indirect effect has to do with the fact that, in a two-sided market, fewer ads imply lower viewer

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7See the Appendix.
disutility from advertisements and hence stronger viewer demand for TV networks (higher viewer willingness to pay). This attracts more viewers which increases the demand for advertising, partially offsetting the initial decrease due to the direct effect (positive effect).

The positive effect is stronger in PB than in MB. We can explain this as follows.\(^8\)

Under mixed bundling, the monopolist operator, in an attempt to appropriate part of the viewers’ higher willingness to pay due to less advertising, will increase the subscription fees of ESPN and the bundle (ESPN+CNN). He will not, however, change the subscription fee of CNN, because the level of advertising on CNN has not changed. The strength of the positive effect is reduced. On the other hand, under pure bundling, the monopolist operator has less freedom in setting his subscription fees. He will be more cautious (compared to MB) in raising the subscription fee, because the bundle is now purchased by all viewers, including those who only like CNN. As a result, the positive effect is reduced less in PB than in MB.

Putting the negative (direct) effect together with the positive (indirect) effect of an increase of ESPN’s advertising fee, we can conclude that the decrease in the quantity demanded of advertising on ESPN is larger under MB than under PB. This implies a steeper slope of the inverse demand function for advertising under MB.

For the slope effect we forced the inverse demand curve under PB to pass through the equilibrium point under MB. Now we allow the location to adjust, following a transition from MB to PB, location effect. From the slope effect we know that when the monopolist switches from MB to PB, there will be less advertising on both TV channels. Less advertising on the rival channel, say CNN, implies higher viewer utility and stronger demand. The monopolist will increase his subscription fee, but given the constraints he faces, he will not completely offset the advertising benefit. As a result the number of multiple demand viewers increases.\(^9\) This increases the demand for advertising on ESPN and shifts the inverse demand function for advertising under MB.

\(^8\)There is also a minor effect that advertising fee affects the advertising level. The decreases of \(\alpha_a\) will make the number of viewers of the rival goes up, and in turn increase the rival’s advertising level, \(\alpha_b\). Furthermore, the increase of \(\alpha_b\) will lower the number of viewers of channel a and thus lower the demand for advertisement on channel a. This effect is strictly dominated, therefore, we just omit the discussion here. The complete discussion can be found in Appendix.

\(^9\)More formally, this can be seen by comparing the equilibrium prices under the two regimes as given by equations (A.5) and (A.1) and the number of viewers as given by equations (A.6) and (A.2). When both \(\alpha_a\) and \(\alpha_b\) decrease the monopolist under MB increases his price by \(t\) exactly offsetting the benefit from the reduction in advertising. Under PB, however, the price increases by a fraction of \(t\) and hence the number of
curve out. The location effect implies higher advertising fee and higher levels of advertising. In our model, the slope effect dominates the location effect and therefore the net result is less advertising in equilibrium (and higher advertising fees) under PB.

\[ \text{\textcopyright figure C.4 } \]

\[ \text{\textcopyright figure C.5 } \]

### 1.4.2 Consumer surplus when bundle is allowed

In this section, we compute the consumer surplus when bundling is allowed. Since we assume that the demand functions are linear, the consumer surplus can be easily found as follows:

\[
CS = \frac{(V - t_\alpha a - t_\alpha b - p_B)^2}{2} + \frac{(1 - t_\alpha a - p_a)^2}{2} + \frac{(1 - t_\alpha b - p_b)^2}{2}
\]

In the PB equilibrium, the consumer surplus is given by,

\[
CS^{PB} = \frac{3}{8(5t + 3)^2(6 + 7t)^2}(-1836t^4V + 1676t^4 + 649t^4V^2 - 5328V^3t^3 + 2178t^3V^2 + 4824t^3
\]

\[
+ 432 + 2757t^2V^2 + 5172t^2 - 5652t^2V - 2592tV + 1548t^2 - 324 + 64V^2)
\]

In the MB equilibrium, the consumer surplus is given by,

\[
CS^{MB} = \frac{1}{8(3t + 2)^2(3t + 4)^2}(33V^2t^4 + 114t^4 - 96Vt^4 + 156V^2t^3 + 480t^3 - 336V^3
\]

\[
+ 284t^2V^2 + 752t^2 - 368t^2V - 128tV + 224t^2V^2 + 512t + 128 + 64V^2)
\]

The following depicts the relationship between consumer surplus and V,

\[ \text{\textcopyright figure C.6 } \]

In general, MB generates less consumer surplus than PB because MB allows the cable operator to price discriminate among the three groups and extract a larger surplus. Furthermore, multiple demand viewers increases under PB.
there are more ads under the MB equilibrium than under the PB equilibrium. Both the price and advertising effect make consumer surplus be lower under the MB equilibrium.

1.5 A la carte pricing (bundling is not allowed)

Now, we assume that a regulator forces the downstream monopolist to sell his products separately (a la carte). The next proposition summarizes the SPNE of this game when $0 \leq V \leq 2$.

**Proposition 3.** There is one type of equilibrium: no bundling NB equilibrium that is described as follows. The cable operator offers only stand alone prices which are relatively low so that all three groups of viewers are served. Subscription fees and cable operator’s profits in this sub-game are given by,

$$
p_{NB}^a = p_{NB}^b = \frac{(3t^2 + 12t + 8)(1 + V)}{6(3t + 2)(3t + 4)}
$$

$$
\pi_{NB} = \frac{(3t^2 + 12t + 8)^2(1 + V)^2}{6(3t + 2)^2(3t + 4)^2}
$$

TV networks’ profits are given by,

$$
\alpha_{NB}^a = \alpha_{NB}^b = \frac{2(1 + V)(t + 1)}{(3t + 2)(3t + 4)}
$$

$$
\varphi_{NB}^a = \varphi_{NB}^b = \frac{(2 + t)(V + 1)^2(t + 1)}{(3t + 2)(3t + 4)^2}
$$

1.5.1 Profit comparisons with and without regulation

Combining the discussion in the previous two sections, we can compare cable operator’s profits in the cases with and without regulation. When there is no regulation, cable operator can choose from three pricing strategies: no bundling, mixed bundling and pure bundling (when serving all three groups of viewers), to maximize its profits, while when there is unbundling regulation, cable operator can only offer the stand-alone prices and have no
bundling equilibrium. Therefore, it is not difficult to understand that cable operator can get higher profits in the equilibria with no regulation.

1.5.2 Number of viewers comparison

Figure C.7 shows the comparison of the number of viewers in the equilibrium, the solid lines measure the number of purchasing viewers when there is no regulation. The dash lines measure those when there is an unbundle regulation. When there is an unbundling regulation, it will attract more lower demand groups viewers but fewer multiple demand group viewers. This is consistent with one-sided market. In the equilibria, the equilibrium prices satisfy: \( \frac{p_{MB}}{2} \prec p_{a}^{NB} \prec p_{a}^{MB} \) and \( \frac{p_{MB}}{2} \prec p_{a}^{NB} \prec p_{B}^{PB} \), therefore, no bundling equilibrium will attract more viewers from small groups, but fewer viewers from multiple demand groups.

1.5.3 Advertisement level comparison

Figure C.8 shows the comparison of the number of viewers in the equilibria, the solid lines measure the number of purchasing viewers when there is no regulation. The dash lines measure those when there is an unbundle regulation. When there is an unbundling regulation, it will attract more lower demand groups viewers but fewer multiple demand group viewers.

No bundling regulation will make TV networks allocate more (or at least the same) time slot on advertisement than no regulation. It is interesting that the advertising level in MB case is exactly the same as the one in NB case. It is because the demand functions (as functions of \( \alpha_{a} \) and \( \alpha_{b} \)) are exactly the same as the functions in MB.

\[
D_{a}^{NB} = \frac{1}{2} + \frac{V}{2} - t\alpha_{a} - \frac{1}{2}t\alpha_{b}
\]

In MB case, cable operator can set different prices for each group. For any given advertising level, the monopolist will set the prices so that the demand in multiple demand group is: \( d_{B}^{MB} = \frac{V-t\alpha_{a}-t\alpha_{b}}{2} \), and the demand in small groups is: \( d_{i}^{MB} = \frac{1-t\alpha_{i}}{2}, i = a \) and \( b \). Therefore, the total viewers of each network are: \( D_{i}^{MB} = d_{B}^{MB} + d_{i}^{MB} = \frac{V+1-2t\alpha_{a}-t\alpha_{b}}{2} \). In NB case, cable operator can only set prices for each individual network, and here, we allow the multiple demand group viewers to form their own bundle. For any given advertising level,
cable operator will set the prices so that the demand in each groups is: $d_i^{NB} = \frac{5}{6} - \frac{1}{2}t\alpha_i - \frac{V}{6}$, $i = a$ and $b$, $d_B^{NB} = \frac{2V}{3} - \frac{1}{2}t\alpha_a - \frac{1}{2}t\alpha_b - \frac{1}{3}$. NB tends to have more purchasing viewers from small demand groups, while MB will have more purchasing viewers from multiple demand group. The difference between the demands of single demand groups in NB case and MB case is $\frac{1}{3} - \frac{V}{6}$ in each group, while the difference in the demands of multiple demand group is $\frac{V}{6} - \frac{1}{3}$. These two offset each other and the advertising demand functions will be the same one in these two subgame.

### 1.5.4 Welfare Comparison

In this section, we compare consumer surpluses with and without regulation. We still start our analysis from the one-sided assumption. When there is no regulation, there is only mixed bundling equilibrium and the consumer surplus from mixed bundling is as follows,

$$CS^{OMB} = \frac{V^2}{8} + \frac{1}{4}.$$ 

The consumer surplus under an a la carte regulation is

$$CS^{ONB} = \frac{V^2}{4} - \frac{V}{2} + \frac{3}{4}.$$ 

In mixed bundling, the monopolist has advantage in extracting the surplus from consumer and yields lower consumer welfare, therefore, consumer can benefit from an a la carte pricing regulation. Nevertheless, in the two-sided market, advertisement plays an important role on consumer surplus. From figure C.9, we can see that the advertisement levels are higher under a la carte pricing than under pure bundling. All else equal, this will make viewers worse off. However, the monopolist will react by lowering the subscription fees. As we discussed in the previous section, when $\alpha_a$ and $\alpha_b$ simultaneously increase, the monopolist has less freedom in setting his subscription fees. It will be more cautious in lowering the subscription fees under PB (the monopolist will lower the bundle price $p_B$ by $\frac{\alpha_a}{3}(\alpha_a + \alpha_b)$ under PB, and the stand alone prices $p_i$ by $\frac{\alpha_a}{2}$ under a la carte pricing). Therefore, networks will lose more
viewers from multiple demand groups and lose fewer from single demand groups under pure bundling given the same amount of advertisement as a la carte pricing. The advertisement acts to lower consumer welfare in both cases, but which case has relative higher effect is ambiguous. When the unregulated outcome is MB equilibrium, the advertisement level is exactly the same as NB case, so there is no advertisement effect here. By using MB strategy, cable operator can extract as much surplus as possible from viewers, therefore the consumer surplus from MB is much lower than the ones from NB and PB.

≺ figure C.9 ≻

1.6 Robustness checks

In this section, we consider the robustness of our results under by loosing the assumption of the independence of two advertisement markets.

1.6.1 The effects of substitution (complementary)

In the main model of this paper, we assume that the demand for the two networks are not independent and allow for the competition between these two markets, that is, the demand function of advertisement is \( \alpha_i = D_i(\alpha_i, \alpha_j) - g_i - \rho g_j \), where \( \rho \neq 0 \). \( \rho \) represents the degree of product differentiation, ranging from -1 (perfect substitutes) to +1 (perfect complements). We believe that non-zero \( \rho \) will only quantitatively affect our result, but not qualitatively. We have discussed when network a increases its advertising fee, it will decrease its own advertising level directly. On the other hand, the decrease of the advertising level will make the total number of viewers on this network goes up thus increase the demand for advertisement and partially offset the direct effect. The non-zero \( \rho \) will only influence the minor indirect effect. When two TV networks are complements to advertisers (\( \rho > 0 \)), the minor effect is soften. When two TV networks are substitutes (\( \rho < 0 \)), the effect is enhanced. However, in both cases, the minor indirect effect is dominated by the first two effects no matter \( \rho \) is positive or negative, and we always have \( |\frac{\partial \alpha_{PB}}{\partial g_{PB}}| < |\frac{\partial \alpha_{MB}}{\partial g_{MB}}| \), implying that the inverse demand curve in PB subgame is steeper than in MB subgame which is the same as
the case with $\rho = 0$. We compare the advertising levels in PB and MB subgames, and find that $\alpha^{PB} < \alpha^{MB}$ when $\rho = -1, -0.5, 0.5$ and $1$, which is the same as the case where $\rho = 0$. It is still possible that the advertising effect dominates the pricing effect, which will result in PB equilibrium when there is no regulation. When the realized equilibrium is mixed bundling when there is no regulation, consumers can be better off from the unbundling regulation, but when the realized equilibrium is pure bundling equilibrium, the effect on consumers is ambiguous.

1.6.2 Effects of marginal cost

In this section, we investigate how the non-zero license fees affect cable operator’s profitability. The marginal cost will affect our result from two perspectives. First, the marginal cost will drive the subscription fees up. Under PB, cable operator cannot distinguish the viewers between the multiple demand group and single demand groups and need to pay both license fees for all the viewers. Cable operator will lose a larger fraction of viewers from small demand groups under PB than under MB or NB. Therefore, it is more difficult to be profitable under PB with non-zero marginal cost. Actually, if there is only this effect, that is, the story in one-sided market, mixed bundling is always preferred to pure bundling. The second perspective plays a profound role. In the two-sided market, networks’ profits are composed of two parts: the advertising revenue and the revenue from license fees. Networks will maximize their total profit from advertisement and license fees, therefore, higher revenue from license fees may affect their decision on the advertising fees and then the quantity demanded for advertisement. Consequently, it will affect the demands of viewers, $d_a$, $d_b$ and $d_B$ and the profitability of the monopolist. First, We assume that the marginal costs are exogeneous and the cable operator take them as given. The second perspective makes
possible that pure bundling is strictly dominant to mixed bundling. \(^{10}\)

We also qualitatively analyze whether our results will still hold if we endogenize the marginal costs. Instead of jumping directly to the very complicated and messy case that license fees are determined by the bilateral bargain between the upstream and downstream firms, we discuss the situation in which the license fees are offered in a "take-it-or-leave-it" contract, which can also provide us some insight on the effects endogeneous marginal costs. There are two possible extreme cases: the upstream TV networks decide the license fees or the downstream cable operator decides them. If the upstream TV networks have the power in determining the license fees, the license fees tend to be high and it is difficult for PB to strictly dominate MB. However, if the downstream firm has the power on license fees, the optimal license fees for the downstream cable operator are zero. We already show in the main model that when license fees are zero, it is possible that PB strictly dominates MB. Therefore, we can conjecture that as the upstream TV networks have more power on the determination of license fees, the license fees tend to be higher thus makes it more difficult for PB to dominate MB.

1.7 Conclusion

We construct a two-sided market model to investigate the incentives of a downstream TV cable operator to bundle TV channels and the welfare implications of a regulation that forces the downstream firm to unbundle. We view each upstream TV network (channel) as a two-sided platform that tries to attract advertisers and viewers. Advertisers prefer more viewers, but viewers receive negative utility from advertisements. The upstream firms sell their content to a downstream monopolist who packages them and offers them to viewers.

\(^{10}\)If we assume the license fees \(r\) are exogenously determined, we have \(p^{PB} > p^{MB}\) if

\[
r < (1/2)(6912 + 1103020t^4 - 63174t^8V + 30459t^8 + 730464t^8 + 1054252t^6 + 69120tV^2 - 2277240t^4V - 1487520t^3V + 151782tV^2 - 441312t^2V - 601920t^2V^2 + 623311t^6 + 6912V^2 + 1005836t^4V^2 + 294336t^2V^2 - 138240tV + 904204t^3V^2 + 697440t^3V^2 + 495367t^6V^2 + 69120t - 13824V - 131754t^6V + 298944t^2 + 20091t^8V^2 - 2206240t^5V + 208806t^7)/(5t + 3)(7t + 6)(3t + 2)(3t + 4)
\]

(78t^4V - 381t^4 + 276t^3V - 1209t^3 + 274t^2V - 1430t^2 + 84tV - 744t - 144)).
When there is no government regulation, the downstream cable operator can choose from the following three pricing strategies: mixed bundling, a la carte pricing, and pure bundling. First we show that pure bundling can strictly dominate mixed bundling for the downstream monopolist. This result is in contrast to the prediction from one-sided models, where mixed bundling is the weakly dominant strategy for a monopolist. The difference here comes from the amount of advertising under the two different regimes, pure and mixed bundling. In particular, pure bundling can attract less advertising, resulting in higher consumer surplus and hence higher profits for the monopolist. The amount of advertising also plays a critical role in determining whether an a la carte regulation is beneficial for the consumers. It may very well be the case that such a regulation, when the unregulated equilibrium is characterized by pure bundling (which is the predominant mode of selling TV channels), hurts consumers (viewers) because it leads to more advertising (for similar reasons there is more advertising under mixed bundling).

Our model uses the TV industry as a motivating example but it can be easily applied to other markets that share similar features. It can also handle cases where both sides of groups receive positive externalities from the other side (as opposed to one receiving negative, viewers in our model).

2.1 Introduction

This paper intends to examine the profitability of a monopolist to bundle its products. We compare the monopolist’s profit from offering two goods as a bundle, the profit from offering two goods a la carte (no bundling), and the profit from a combination of both (mixed bundling). In an one-sided market, when the monopolist only knows the distribution of consumers’ willingness to pay for each good, instead of each individual consumer’s willingness to pay, bundling is a useful tool to reduce the heterogeneity of consumers. Compared to the demand curve of individual goods, the demand curve of the bundle will be flatter and more concentrated, hence bundling products can help the monopolist to extract more surplus. We use a numerical example which is similar to the examples in Crawford and Cullen (2007) and Bakos and Bryjolfsson (1999) to show how bundling may flatten the demand curve. Figure 1 exhibits the demands for a bundle of 2 goods and a bundle of 20 goods when the demand for a single good is normally distributed with mean equal to 2 and variance 1. The blue curve represents consumers’ demand for a good, while the green curve is their willingness-to-pay (WTP) for a good under bundling where we assume consumers’ WTP can be equally divided among the products in a bundle. As the bundle size grows, the demand curve becomes flatter progressively because the number of consumers with extreme preference decreases. Facing a flatter demand curve, the monopolist can extract more surplus from consumers (Schmalensee (1984)). Bakos and Bryjolfsson (1999) show that bundle profit converges to total surplus as bundle size increases without bound if the marginal cost for bundling components is zero.

< figure C.10 >

Mixed bundling is the weakly dominant strategy to pure bundling. Compared to pure bundling, the monopolist is able to generate some demand for individual goods by offering stand-alone prices which is slightly lower than the price of bundling (Schmalensee (1984))
and McAfee et al. (1989)). Our paper finds similar results if we do not include advertisement in our model. However, when we extend the literature from an one-sided market to a two-sided market, the above result will not always hold. Chen and Serfes (2010) use cable TV industry which wants to bring two different groups of agents, viewers and advertisers, on board as an example. In this paper, we assume that viewers place a positive externality on advertisers while advertisement brings some nuisance cost to viewers. We show that it is possible for pure bundling to strictly dominate mixed bundling because pure bundling causes less advertisement which in turn lowers viewers’ nuisance cost from advertisement and boosts viewers’ willingness-to-pay. In this paper, we have a more general assumption on consumer preference for two goods by allowing for a correlation between the preferences. We find that pure bundling makes the monopolist better off if consumers’ willingness-to-pay for two goods are sufficiently negatively correlated.

This paper is also related to extant literature on demand rotation. Actually, bundling two goods together as a package will reduce consumers’ heterogeneity but consumers’ mean willingness-to-pay remains unchanged, causing the demand curve flattened. As the correlation of preferences becomes increasingly positive, the demand curve tends to rotate clockwise. Johnson and Myatt (2006) provide a very intuitive explanation on how demand rotation affects profitability. They find that when consumers’ preference for a product is relatively homogeneous so that the monopolist has a "mass market" (serve a large fraction of consumers), the firm profit increases as the preference become less dispersed because the marginal consumer’s willingness to pay increases. By contrast, when consumers’ preference for a product is relatively heterogeneous hence the firm can only serve a small "niche market", the firm can benefit from a more dispersed market because the willingness-to-pay of the marginal consumer increases as demand rotates clockwise. Overall, as the preference becomes more dispersed, the profit is "U-shaped". Our paper also shows similar results (tables 1 and 2). When consumers’ willingness-to-pay is sufficiently high so that all consumers have positive willingness-to-pay, the monopolist will charge a price that is lower than the mean willingness-to-pay. As demand curve rotates clockwise (the correlation becomes
increasingly positive), firm profit tends to decrease. When consumers’ willingness-to-pay is low so that the market size is small, the monopolist will charge a price higher than the mean willingness-to-pay. As demand curve rotates clockwise, firm profit tends to increase.

Following Chen and Serfes (2010), this paper investigates the profitability of bundling and the effect of an a la carte regulation in a two-sided market framework. A literature review on two-sided markets and the effects of an a la carte regulation can be found in Chen and Serfes (2010). This paper relaxes two important assumptions in Chen and Serfes (2010). First we make a more general assumption about consumers’ preference on two goods. Viewers’ preference to each good follows a normal distribution and correlated. These two goods can be either substitutes (the preferences are negatively correlated) or complements (the preferences are positively correlated). Second, we endogenize the license fee by allowing for a pair of downstream and upstream firms to bilaterally negotiate over the licenses fee.

The license fee plays an important role in our results. It affects our results in two ways. First, the license fee is the marginal cost to the downstream monopolist. A higher marginal cost will boost up the price charged by downstream firms. Second, we model the cable TV industry as a two-sided market, where the price composition between two sides will affect the volume of trade (Rochet and Tirole (2006)). In this two-sided market, TV networks’ profit is composed of two parts: one is the revenue from advertising and the other is the license fee from the cable operator. Different price composition between these two sides will generate different profits to TV networks because of the cross-group externalities.

We assume that each pair of upstream and downstream firms negotiate over license fees to maximize the Nash product. Depending on market size, an a la carte regulation will decrease (increase) license fee if market is large (small). Roughly speaking, whether the license fee will increase or decrease under a la carte regulation depends on the demand elasticity. A detailed explanation can be found in section 2.4. When we incorporate both advertisement and license fee in our model, some interesting results are brought about by the change in cross-group externalities, t and n. When the network effects are low, that is, t and n are both low, advertisement level and license fee are the highest under pure bundling (compared to
no bundling and mixed bundling). A la carte regulation will make consumers better off. If the per unit nuisance cost from advertisement to viewers increases, that is, advertisement brings strong disutility to viewers and significantly lower viewer willingness-to-pay, TV network will increase the price for advertisement to lower the advertisement level, and as a result lower its negative externality. However, when the cross-group externality from viewers to advertisers increases, that is, the number of viewers strongly increases advertiser demand, then TV networks, as two-sided platforms, will lower license fee so that it can attract more viewers and create strong positive externality to boost advertiser demand. This finding demonstrates that, in a two-sided market framework, platforms compete to attract agents from different groups (e.g., Caillaud and Julien (2003) and Armstrong (2006)). A main goal of this paper is to show how the composition of the aggregate price affects the volume of trade (Rochet and Tirole (2006)).

Our model is not limited to TV industry and it can be applied to other markets that have similar features, e.g., newspapers, credit cards, etc. The negative externality that one side (advertisers) imposes on the other (viewers) is not crucial for our results. Our main insights continue to hold even when we assume positive externalities on both sides. One of the main points in this paper is that the interaction between the two sides affects the profitability of bundling by influencing the amount of advertising. Basically, pure bundling helps to reduce the amount of the negative externality. In a model with positive externalities on both sides (e.g., newspapers where ads are beneficial to the readers, such as coupons, job listings etc.) pure bundling increases the amount of positive externality, i.e., more advertising in that setting, making the monopolist better off.

The remainder of the paper is organized as follows. The main model is presented in section 2.2, followed by the benchmark equilibria in section 2.3. The main analysis of the two-sided model is provided in section 2.4, and section 2.5 is welfare analysis. We conclude in section 2.6.
2.2 Model

There is a downstream monopolist cable operator offering two channels: \( a \) and \( b \). The monopolist can choose to offer these two channels either a la carte (interchangeable with “no bundling”), together as a bundle (defined as “pure bundling”), or a combination of both (defined as “mixed bundling”). Under a la carte, viewers are allowed to build the bundle by paying the price that is equal to the sum of the price of each individual channel. Under pure bundling, viewers can only choose to either buy the bundle or nothing. Under mixed bundling, viewers have four choices: channel \( a \) only, channel \( b \) only, a bundle of both \( a \) and \( b \), and nothing.

2.2.1 Downstream firm profit

The mass of viewers is equal to 1. Viewers’ preference \( v_i \) for channel \( i \) \((i = a, b)\) is normally distributed with the mean equal to \( i \) and the variance \( \sigma_i^2 \). Viewers’ preferences for these two goods are correlated with covariance \( \sigma_{ab} \). When the covariance is negative, these two goods are negative correlated and can be considered as a pair of substitutes; when the covariance is positive, these two goods are a pair of complements. Viewers, taking the advertising levels on each channel and the prices for the combinations as given, buy the combination which gives them highest utility.

We assume that consumers are advertisement averse and advertisement brings some nuisance cost (disutility) to consumers. Let \( t \) denote the per unit nuisance cost from advertisement to viewers and \( \alpha_i \) the advertising level on channel \( i \), consumer net utility from each channel is equal to \( v_i - t\alpha_i - p_i \) where \( p_i \) is the price for channel \( i \).

**No bundling**

\(< \text{figure C.11} >\)

If these two channels are offered separately, and viewers’ net utility (the willingness-to-pay for an individual channel minus the nuisance cost from advertisement on this channel) is greater than the stand-alone price, viewers will choose to buy this channel,
if $v_i - t\alpha_i > p_i$, viewer will buy channel $i$

The corresponding demand for each channel is given as follows,

$$d_i = 1 - F(p_i + t\alpha_i), i = a, b$$

where $F$ is $CDF \ N(\mu, \sigma_i^2)$

The profit function for the monopolist is

$$\Pi = p_a + p_b = max_{p_i, i=a,b}(1 - F(p_i + t\alpha_i))(p_i - c_i) \quad (2.1)$$

where $c_i$ is the license fee charged by the TV network. The downstream monopolist takes the advertising levels and license fees as given and choose the stand-alone prices $p_i$ to maximize its profit.

**Pure bundling**

If these two goods are offered together as a bundle, based on viewers’ preference, there are three possibilities,

- some viewers have very weak preference on channel $b$ where the reservation price from channel $b$ is lower than the nuisance cost of the advertisement on this channel, but they have very strong preference to channel $a$. In this case, these viewers will choose not to watch channel $b$, therefore only when their willingness to pay for channel $a$ is sufficiently high will they subscribe the bundle,

  if $v_b < t\alpha_b$ and $v_a - t\alpha_a > p_B$, subscribe the bundle but don’t watch $b$

- similarly, some viewers have very weak preference on channel $a$ but very strong preference to channel $b$, then when their willingness to pay for channel $b$ is sufficiently high, they will still subscribe the bundle

  if $v_a < t\alpha_a$ and $v_b - t\alpha_b > p_B$, subscribe the bundle but don’t watch $a$
• viewers don’t have weak preference on either channel. Then when viewers’ net aggregate utility from both channels (the aggregate willingness to pay minus the total disutility from advertisements on both channels) is greater than the bundle price, viewers will buy the bundle,

\[ v_a > t \alpha_a \text{ and } v_b > t \alpha_b \text{ and } v_a + v_b - t(\alpha_a + \alpha_b) > p_B, \] subscribe the bundle

The demand for the bundle is as follows,

\[ q_{PB} = d_a + d_b + d_B \]

where

\[ d_a = \int_{-\infty}^{t \alpha_b} \int_{p_B + t \alpha_a}^{\infty} f(v_a, v_b) dv_a dv_b \]

\[ d_b = \int_{-\infty}^{t \alpha_a} \int_{p_B + t \alpha_b}^{\infty} f(v_a, v_b) dv_a dv_b \]

\[ d_B = \int_{t \alpha_a}^{(p_B + t \alpha_a + t \alpha_b)/2} \int_{p_B + t \alpha_b - v_a}^{\infty} f(v_a, v_b) dv_a dv_b \]

\[ + \int_{t \alpha_b}^{(p_B + t \alpha_b + t \alpha_a)/2} \int_{p_B + t \alpha_a - v_b}^{\infty} f(v_a, v_b) dv_a dv_b \]

\[ + \int_{(p_B + t \alpha_a + t \alpha_b)/2}^{\infty} \int_{(p_B + t \alpha_a + t \alpha_b)/2}^{\infty} f(v_a, v_b) dv_a dv_b \]

where \( f(v_a, v_b) \) is the density function of the bivariate normal distribution with mean \( \begin{pmatrix} \mu_a \\ \mu_b \end{pmatrix} \) and the covariance matrix \( \begin{vmatrix} \sigma_a^2 & \sigma_{ab} \\ \sigma_{ab} & \sigma_b^2 \end{vmatrix} \). The portion of viewers \( d_a \) will only watch channel \( a \), viewer \( d_b \) will watch channel \( b \) and \( d_B \) both.

The profit function for the monopolist is

\[ \Pi_{PB} = \max_{P_{PB}} D_{PB}(p_{PB} - c_a - c_b) \]

where \( D_{PB} = d_a + d_b + d_B \)
Mixed bundling

If the downstream monopolist offers the channels separately and together as a bundle simultaneously, the viewers can choose the product that generates the highest net utility.

• The viewers will choose to subscribe channel \(i\) only, iff

\[
v_i - p_i - t\alpha_i > v_i + v_{-i} - p_B - t(\alpha_i + a_{-i}) \quad \text{and} \quad v_i - p_i - t\alpha_i > 0
\]

• The viewers will choose to buy the bundle iff

\[
v_a + v_b - p_B - t(\alpha_a + \alpha_b) > 0
\]

and

\[
v_i - p_B + p_{-i} - t\alpha_i > 0
\]

Therefore, the respective demand for each product can be described as follows:

\[
d_{MB}^{\alpha_a} = \int_{-\infty}^{p_B - p_a + t\alpha_b} \int_{p_a + t\alpha_a}^{\infty} f(v_a, v_b) dv_a dv_b
\]

\[
d_{MB}^{\alpha_b} = \int_{-\infty}^{p_B - p_b + t\alpha_a} \int_{p_b + t\alpha_b}^{\infty} f(v_a, v_b) dv_a dv_b
\]

\[
d_{MB}^{\alpha_B} = \int_{p_B - p_a + t\alpha_b}^{(p_B + t\alpha_a + t\alpha_b)/2} \int_{p_B + t\alpha_a + t\alpha_b - v_a}^{\infty} f(v_a, v_b) dv_a dv_b
\]

\[
+ \int_{p_B - p_b + t\alpha_a}^{(p_B + t\alpha_a + t\alpha_b)/2} \int_{p_B + t\alpha_a + t\alpha_b - v_b}^{\infty} f(v_a, v_b) dv_a dv_b
\]

\[
+ \int_{(p_B + t\alpha_a + t\alpha_b)/2}^{\infty} \int_{(p_B + t\alpha_a + t\alpha_b)/2}^{\infty} f(v_a, v_b) dv_a dv_b
\]

The downstream firm profit function is given as follows:

\[
\Pi_{MB} = \max_{p_{MB}^{\alpha_a}, p_{MB}^{\alpha_b}, p_{MB}^{\alpha_B}} d_{MB}^{\alpha_B} (p_{MB}^{\alpha_B} - c_a - c_b) + d_{MB}^{\alpha_a} (p_{MB}^{\alpha_a} - c_a) + d_{MB}^{\alpha_b} (p_{MB}^{\alpha_b} - c_b)
\]

2.2.2 Upstream firm profit

The upstream firms (TV channels)' revenues is composed of two parts, one of which is from the license fee charged from the downstream operator, and the other is the advertising
revenue. Here, we assume there is no marginal cost of both sides for TV channels. The number of viewers places a positive externality on advertisers. The more viewers each channel has, the higher reservation price advertisers want to pay to advertise on that channel. Note, in pure bundling, the consumers $d_a$, $d_b$, and $d_B$ will buy both channels, but the consumers $d_a$ and $d_b$ have strong preference to channel a and b respectively, but strongly dislike the other channel. We assume that these consumers will only watch the channel they like and ignore the channel they dislike. Therefore there is a difference between the subscribers and viewers. For channel a, its total number of viewers, $q_a$, will be $d_a + d_B$ instead of $d_a + d_b + d_B$. We assume that the advertiser willingness-to-pay will increase by $n$ if the number of viewers increases by 1. Therefore, the inverse demand for advertising on channel $i$ is

$$g_i = nq_i - \alpha_i$$

where $g_i$ is the advertising fee for advertising on channel $i$. The profit from advertising is given by

$$\Phi_i^A = (nq_i - \alpha_i)\alpha_i$$

Let $c_i$ be the license fee per viewer. Cable operator needs to pay the license fee for each subscriber no matter he watch this channel or not. The profit from charging license fee is

$$\Phi_i^L = c_iD_i$$

where $D_i$ is the number of subscribers that channel $i$ has, i.e. $D_a = d_a + d_b + d_B$ in pure bundling. TV channel $i$’s profit function is given by,

$$\Phi_i = \Phi_i^L + \Phi_i^A = max_{\alpha_i} c_iD_i + (nq_i - \alpha_i)\alpha_i$$

TV networks choose advertising levels to maximize the profit.
2.2.3 Bargaining

At the same time, the upstream and downstream firms bargain for the license fee. Here, we use a Nash Bargain approach to solve for the license fee. There are extensive studies on bilateral negotiations. Similar as the environments in Horn and Wolinsky (1988), Hart and Tirole (1990), McAfee and Schwartz (1994), and Segal and Whinston (2003) where there are more than one firm in one side of the market, there are two upstrams in our model. The downstream firm will bargain with each upstream firm (i.e. Comcast-CNN and Comcast-ESPN) separately and simultaneously. The outcome of Comcast from the negotiation with CNN depends the outcome of the negotiation between Comcast and ESPN. We assume that each pair take the outcome from the other pair as given. Each pair of upstream and downstream firms will choose license fee \( c_i \) to maximize the Nash product. We assume that the license fees are linear. The Nash Product for the bargaining over the license fees between the operator and network \( i \) is defined as follows.

\[
NP_i = (\Pi^Y - \Pi^N)^{\lambda}(\Phi^Y_i - \Phi^N_i)^{(1-\lambda)}
\]

\( \lambda \) is the bargain power that the downstream monopolist has. In this paper, the upstream firm and downstream firm are assumed to have equal bargain power, that is, \( \lambda = 0.5 \).

No bundling

Under no bundling case, if the cable operator and network \( i \) reach an agreement, the cable operator’s profit will be the sum of the profits from selling both channels, \( \Pi^Y = \Pi \), as shown in (2.1). Network \( i \)’s profit is \( \Phi^Y_i = \Phi_i \). When the cable operator and network \( i \) do not reach an agreement, the cable operator’s profit will become the profit of only offering channel \( j \), \( \Pi^N = \pi_j = (1 - F(p_j + t\alpha_j))(p_j - c_j) \), and the network \( i \)’s profit is zero (there is also no advertising revenue because the advertisers’ reservation price is equal to the number of viewers of this channel, which is zero if the agreement cannot be reached), \( \Phi^N_i = 0 \).
Therefore, we can explicitly write down the Nash product function,

\[ NP_i^{NB} = \max_{c_i} (\Pi^Y - \pi_j)^\lambda (\Phi_i^Y)^{(1-\lambda)} = (\pi_i)^\lambda (\Phi_i)^{(1-\lambda)} \]

**Pure bundling**

Under pure bundling case, if the cable operator and network i reach an agreement, the cable operator’s profit will be the profit from selling both channels as a package, \( \Pi^Y = \Pi_{PB} \), as shown in (2.2.1). Network i’s profit is \( \Phi_i^Y = \Phi_i \). When the cable operator and network i do not reach an agreement, the cable operator’s profit will become the profit of only offering channel j, \( \Pi^N = \pi_j = (1 - F(p_j + t\alpha_j))(p_j - c_j) \), and network i’s profit is zero (there is also no advertising revenue because the advertisers’ reservation price is equal to the number of viewers of this channel, which is zero if the agreement cannot be reached), \( \Phi_i^N = 0 \). Therefore, we can explicitly write down the Nash product function,

\[ NP_i^{PB} = \max_{c_i} (\Pi^{PB} - \pi_j)^\lambda (\Phi_i^Y)^{(1-\lambda)} \]

\( \pi_j \) is the monopolist’s optimal profit from channel j when it cannot reach an agreement with channel i. Here \( p_j \) should not be the same as the profit from channel j in no bundling because the license fee \( c_j \) will be different from the no bundling case.

**Mixed bundling**

When the cable operator and network i reach an agreement, the cable operator’s profit will be \( \Pi^Y = \Pi_{MB} \), as shown in (2.2.1). Network i’s profit is \( \Phi_i^Y = \Phi_i \). When the cable operator and network i do not reach an agreement, the cable operator’s profit will become the profit of only offering channel j, \( \Pi^N = \pi_j = (1 - F(p_j + t\alpha_j))(p_j - c_j) \), and the network i’s profit is zero (there is also no advertising revenue because the advertisers’ reservation price is equal to the number of viewers of this channel, which is zero if the agreement cannot
be reached), \( \Phi_i^N = 0 \). Therefore, we can explicitly write down the Nash product function,

\[
NP^MB_i = \max_{c_i} (\Pi^MB_i - \pi_j)^\lambda (\Phi_i^Y)^{(1-\lambda)}
\]

\( p_j \) is the monopolist’s optimal profit from channel \( j \) when it can’t reach the agreement with channel \( i \). Here \( p_j \) should not be the same as the profit from channel \( j \) in the no bundling because the license fee \( c_j \) will be different from the no bundling case. We model a three stage game:

- **Stage 1:** The upstream monopolist cable operator announces whether to offer these two goods as a bundle or a la carte.

- **Stage 2:** The downstream TV channels set advertising levels, \( \alpha_i \). Upstream and downstream firms bilaterally negotiate over license fees, \( c_i \).

- **Stage 3** Downstream firms choose prices, \( p_i \).

Due to the complexity of two-dimension demand function, it is impossible to derive the analytical expression \( \frac{\partial p_i}{\partial c_i} \) and \( \frac{\partial p_i}{\partial \alpha_i} \) when solving backward for the equilibria. Therefore, we derive the equilibria numerically. In the numerical estimation, we hold the standard deviation of the valuation to the goods, \( \sigma_i \), constant, which is equal to 10, while we vary other parameters. The key parameters of the model that affect the equilibrium outcomes are: (1) Mean valuation to two goods, \( \mu_i \). We define the market as a ”big market” when \( \mu_i \) is equal to 30, where almost every consumer has a positive valuation to the goods, and define the market as a ”small market” when \( \mu_i \) is equal to 10 or 15, where there are some portions of the viewers that have negative valuation. (2) The cross-group externalities, \( t \) and \( n \). When \( t \) and \( n \) are low, the externalities are low. As \( t \) and \( n \) increase, the externalities enhance. (3) The correlation coefficient of the viewers’ valuation to two goods, \( \rho \). These two goods are substitutes to consumers when \( \rho \) is negative, independent when \( \rho \) is zero, and complements when \( \rho \) is positive.
2.3 Benchmark: no upstream firm

First, we look at the equilibria where there is no upstream firm, that is, there is no advertisement and license fee. Table B.1 shows the equilibria under no bundling, pure bundling and mixed bundling. The result is consistent with the literature on bundling where mixed bundling is a weakly dominant strategy for a monopolist, e.g., Schmalensee (1984), and McAfee, et.al (1989). By offering the mixed bundle the monopolist is able to sort the viewers and price discriminate. Under mixed bundling, viewers pay higher price for a single channel than under no bundling, while the price for the bundle is slightly lower than under pure bundling. Not surprisingly, this flexibility boosts the monopolist’s profit. The number of viewers under mixed bundling and pure bundling are significantly higher than under no bundling (the number of viewer under MB is slightly higher than under PB but no significantly).

The change in the profit as the correlation coefficient changes is consistent with the findings in Johnson and Myatt (2006). When consumers’ mean reservation price is high where the firm has a large market, the firm will charge a relatively low price to serve the mass of the market. As the correlation coefficient increases (demand rotates clockwise), the monopolist profit decreases and the monopolist prefers a low dispersion. However, when consumers’ mean reservation price is low so that the monopolist will charge a high price to serve a niche portion of the consumers, the monopolist prefers a high dispersion, and its profit will increase as the correlation coefficient increases.

**Result 1:** When there is no upstream firm, mixed bundling is the weakly dominant strategy of the monopolist. In a big market, the profit from pure bundling decreases as the correlation coefficient increases. However, when the market is small, as the correlation coefficient increases, the profit from pure bundling will increase.
2.4 Equilibria with upstream firm

In this section, we discuss the numerical equilibria with upstream firms. First, we discuss the equilibria with advertisement but assume that the license fees are zero. By comparing these equilibria to the benchmark model, we are able to see how advertisement will affect the results. Second, by assuming advertising levels equal to zero, we investigate how an a la carte regulation affects the license fees. Finally, we incorporate both advertisement and license fees to investigate how the price composition of the TV network, a two-sided platform, affects the volume of trade.

2.4.1 No license fees but with advertisement

In this section, we assume that the license fees are equal to zero. The upstream TV networks choose the advertising levels to maximize their profit. Table B.3 shows the equilibria where both cross-group externalities, t and n, equal to 1. Table B.4 shows the equilibria with larger cross-group externalities (t and n are both equal to 10). The advertising levels are the lowest under no bundling because no bundling is disadvantageous in attracting viewers. When the cross-group externalities are high, the advertising levels increase. Compared to the equilibria when t and n are low, the advertising levels are significantly higher in the equilibrium when t and n are high, while the number of viewers is significantly lower. This is because as n increases, the advertiser’s WTP is enhanced because of the positive externality from viewers. However, higher advertising levels will lower viewers’ demand especially when t is also high.

Note, as t is high, it is possible that pure bundling strictly dominates mixed bundling (i.e. when $\rho = -0.5$, the advertising level is 1.76 under PB and 1.87 under MB. The monopolist cable operator profit is 14.84 under PB and 13.57 under MB). This is because the advertising levels are lower under pure bundling than under mixed bundling. A lower advertising level means lower disutility for viewers which will boost viewers’ demand for the channel, and allow the monopolist cable operator to charge higher price. This result is consistent with
the main finding in Chen and Serfes (2010). The reason why the advertisement level will be lower under pure bundling can been seen in Chen and Serfes (2010) as well.

**Result 2:** In a two sided market, it is possible that pure bundling strictly dominates mixed bundling. This is because the advertising levels are lower under pure bundling, which will boost viewer demand for channels and allow the cable operator to charge higher price.

2.4.2 No advertisement but with license fees

In this section, we focus on the effect on the license fees when there is an a la carte regulation. Crawford and Yurukoglu (2009) show an a la carte regulation will increase license fees, however, Rennhoff and Serfes (2009) show that the license fees will be lower under a la carte regulation. Both these two papers assume that license fees are determined by the negotiation of the upstream and downstream firms. In this paper, we demonstrate that both results are possible depending on the size of the market. The numerical simulation shows that the license fees are lower under a la carte in a large market where all viewers have positive willingness to pay (as shown in table 5 where $\mu_i = 30$), and are higher under a la carte in a small market where a significant portion of viewers have negative willingness to pay (as shown in table 6 where $\mu_i = 15$).

From first order condition of the Nash product,

\[
\frac{dNP}{dc_i} = 2 - \epsilon^q_p - \epsilon^q_c = 2 - |\epsilon^q_p|(1 + \epsilon^p_c)
\]

where $\epsilon^q_p$ is viewers’ demand elasticity of price, $\epsilon^q_c$ is the viewers’ demand elasticity of license fee and $\epsilon^p_c$ is the elasticity of price (final price) for channel to license fee (marginal cost).

If $\frac{dNP}{dc_i}$ is higher (lower) than zero, license fees increase (decrease). When we move from pure bundling to no bundling, whether license fees will increase or decrease depends on the demand elasticity of price. If demand elasticity is high (low), the first order derivative of Nash product will be lower (higher) than zero, and the license fees will decrease (increase).
If we fix the license fee at its level under pure bundling, the demand is more elastic when is high. Let us take \( \rho = -0.5 \) as an example. When \( \mu_i = 30 \), if we fix the license fee at the level of 13.13, then \( |\epsilon_p| = 1.8843 \), \( \epsilon_c = 0.2040 \), and \( \frac{dNP_{NB}}{dc_i}|_{c=c_{PB}} = -0.2687 \). Therefore, when moving from pure bundling to no bundling, license fees decrease. When \( \mu_i = 15 \), if we fix the license fee at the level of 6.72, \( |\epsilon_p| = 1.5798 \), \( \epsilon_c = 0.2056 \), and \( \frac{dNP_{NB}}{dc_i}|_{c=c_{PB}} = 0.096 \). In this case, license fees increase from pure bundling to no bundling.

Even though in the case of mean willingness-to-pay equal to 30 where the license fees are higher under pure bundling, it is still possible that the monopolist gets higher profit from pure bundling. This is an extension of extant bundling literature that bundling is more profitable than no bundling even if the marginal cost is not zero. As far as the correlation coefficient is negative sufficiently, the monopolist is able to sort consumers and create the demand, thus increase its profit even though the monopolist needs to pay higher marginal cost. The profit from the demand creation will exceed the loss in profit due to higher marginal cost. **Result 3:** License fees will increase (decrease) in a small (big) market when there is an a la carte regulation.

### 2.4.3 With license fees and advertisement

In this section, we include the license fees and advertisement in the model. We assume that TV networks will choose the advertising level to maximize their profit. Simultaneously, each pair of upstream TV network and downstream cable operator will negotiate over the license fee to maximize the Nash product.

As summarized in tables B.8-B.11, the total number of viewers is the highest under pure bundling and the least under no bundling, therefore, the advertising levels are the highest under pure bundling and the lowest under no bundling, which indicates that an a la carte
regulation will cause TV networks to allocate less advertisement.

As shown in table B.8, where \( t=1 \) and \( n=1 \), the license fees are the highest under pure bundling. However, if we increase both the cross-group externalities, the license fees are significantly lower under pure bundling. There are two effects associated. The first effect is related to the negative externality from advertisement to viewers. Higher per unit nuisance cost will lower viewers’ willingness to pay, which will in turn shift viewers’ demand inside, which will pull the final price and marginal cost. The second effect is associated with the positive externality from viewers to advertisers. At any level of viewers, higher \( n \) indicates higher advertisers’ willingness to pay. Hence the TV network is able to attract more advertisers, therefore, the TV network, as a platform of two different groups of agent, is willing to lower the license fee so that it can increase the volume of trade (Rochet and Tirole (2006)).

Tables B.10 and B.11 also illustrate the result that in a two-sided market, the composition of the aggregate price affects the volume of trade. In table B.10 where there is small negative externality from advertisement to viewers (\( t=1 \)) but high positive externality from viewers to advertisers (\( n=5 \)), compared to the result in table B.8, TV networks will agree to lower license fees to attract more viewers, as a result, increasing its revenue from advertisement. However, in Table 11 where there is high negative externality from advertisement to viewers (\( t=3 \)) but low positive externality from viewers to advertisers (\( n=1 \)), TV networks would like to give up the revenue from advertisement but increase the revenue from license fees by charging higher license fee to the cable operator.

**Result 4:** When both \( t \) and \( n \) are low, the advertising level and license fees are the highest under pure bundling. When the cross-group externality from viewers to advertisers, \( n \), is strong while the disutility from advertisement to viewers, \( t \), remains low, the TV networks are willing to lower the revenue from license fees so that they can increase the revenue from advertisement. However, when the disutility from advertisement to viewers is high but the cross-group externality from viewer to advertiser is low, the TV networks will focus on the revenue from license fees and give up the revenue from advertisement.
Result 5: When both $t$ and $n$ are high, the license fees will be the lowest under pure bundling. Pure bundling strictly dominates mixed bundling.

2.5 Welfare analysis

In this section, we discuss the welfare properties of the equilibria. There are four groups of agents in our model: an upstream cable operator, two downstream TV networks, viewers, and two groups of advertisers who advertise on TV networks. The social welfare is defined as the sum of consumer surplus, downstream firm profit, upstream firms’ profits and advertiser surplus.

$$TS = CS + \pi^D + U + CS^{ad}$$

The calculation of consumer surplus, $CS$, downstream firm profit, $\pi^D$, upstream firm profit, $\pi^U$ can be found in section (3.3). The advertiser surplus from advertising on channel $i$ is as follows:

$$CS^{ad}_i = \int_0^{\alpha_i^*} g_i(\alpha_i, \alpha_{-i}^*) - g_i^*(\alpha_i^*, \alpha_{-i}^*) d\alpha_i$$

In the discussion of the welfare properties, we focus on the equilibria where $\mu = [30, 30]$. The factors that will affect the welfare properties in the equilibria can be characterized as: network effect and marginal cost effect. Network effect refers to the fact that the changes in the values of cross-group externalities, $t$ and $n$, will affect the advertising levels in the equilibria, and the change in advertising levels will place an negative effect on the consumer welfare and total social welfare. Marginal cost effect refers to the change in license fees will affect the prices of the channels that consumers need to pay, therefore, will affect the allocation of the welfare among consumers, the downstream cable operator and upstream TV networks.

2.5.1 Welfare with no upstream firm

Table B.12 shows the welfare of downstream monopolist and the consumers when there is no advertisement and license fee. Pure bundling can reduce consumer heterogeneity and
flatten the demand curve so that the monopolist can extract more surplus from consumers. When the correlation coefficient of consumers’ valuation to two channels, \( \rho \), is negative, that is, when these two channels are substitutes to consumers, the advantage of pure bundling in extracting surplus from consumers is significant. Furthermore, mixed bundling is the second degree price discrimination and has advantage in extracting surplus from consumers. Consumer can benefit from an a la carte regulation. The monopolist will be worse off from an a la carte regulation. An a la carte regulation will lower the social welfare.

Result 6: When there is no upstream firm, an a la carte regulation will benefit consumers while hurt the downstream cable operator, and the total surplus will decrease.

2.5.2 Welfare with advertisement but no license fee

Advertisement plays an important force on the effect of an a la carte regulation. Table B.13 is the welfare when cross-group externalities are low, that is, both \( t \) and \( n \) are equal to 1. Overall, since consumers dislike advertisement, advertisement reduces welfare. Under a la carte, TV networks can attract less viewers, making them less attractive to advertisers. The advertising levels are the lowest under a la carte. Table B.14 shows the welfare when both \( t \) and \( n \) are equal to 10. As \( n \) increases, the advertisers’ WTP is enhanced, so the advertising levels increase. Higher advertising levels will lower viewers’ demand especially when \( t \) is also high. Compared to the results in Table B.14, we can see that as cross-group externalities increase, the downstream firm’s profit is significantly lower. Upstream firms’ revenue (revenue from advertisement) is significantly higher.

The effect of an a la carte regulation on the cable operator is different from the case without upstream firms. It is possible that the cable operator may benefit from an a la carte regulation no matter the unregulated equilibrium is pure bundling or mixed bundling. This is because a la carte regulation will lower the negative externality. Also, an a la carte regulation may increase the social welfare when the correlation coefficient of the valuations to
these two channels is positive.

Result 7: When incorporating advertisement in the model, the downstream cable operator, thus the total social welfare, may benefit from an a la carte regulation when the cross-group externalities are high.

2.5.3 Welfare with advertisement and license fee

In this section, we incorporate license fees in the model. Due to double marginalization, the change in license fees will affect the price charged by the downstream firm to the viewers. As a result, the license fees will affect consumers’ welfare. As discussed in section 2.4, an a la carte regulation will either increase or decrease the license fees depending on the market size. In a small market, the license fees are higher under an a la carte and therefore, bring about some negative effects on consumer welfare.

Tables B.15 and B.16 show the welfare with both advertisement and license fees. Table B.15 shows the welfare when $t$ and $n$ are low. The advertising level and license fees are the highest under pure bundling, therefore, the upstream TV network profit will be the highest. Both high license fees and advertisement level will act to lower consumer welfare, therefore, consumer surplus is the lowest under pure bundling. From the perspective of the downstream cable operator, since the license fees are lower under a la carte, it is possible that it may be better off from an a la carte regulation.

Table B.16 represents the welfare when the network effect is strong. Generally speaking, a higher $n$ means that viewers are more valuable to advertisers and TV networks are willing to lower license fees to increase the total number of viewers (first effect). This will help to increase consumer surplus. However, more viewers each channel has, more advertisement will be placed. The higher advertisement will first directly lower consumer welfare due to the nuisance cost (second effect). Furthermore, the higher advertisement level will lower consumers’ willingness-to-pay and consequently affect the final price that viewers pay for the channels and the license fees that the cable operator pays to TV networks (third effect).
The third effect is the strongest under pure bundling because viewers' demand is more elastic under pure bundling, therefore, cable operator is more willing to lower price. This will help to increase consumer welfare. Overall, compared to consumer surplus with low network effect, consumer surplus decreases under no bundling and mixed bundling as network effect increases, while consumer surplus under pure bundling with strong network effect increases. The license fees are significantly lower under pure bundling than under mixed bundling and no bundling, which increase the profit of the downstream cable operator. It is possible that pure bundling strictly dominates mixed bundling.

Result 9: In the model with advertisement and license fees, if the unregulated equilibrium is pure bundling equilibrium, an a la carte regulation may make consumers worse off when both \( t \) and \( n \) are high. When both \( t \) and \( n \) are low, the downstream cable operator may benefit from an a la carte regulation.

2.6 Conclusion

In this paper, we conduct a numerical simulation by relaxing two assumptions made in the first chapter. First, viewers' willingness to pay for the channels is not assumed uniformly distributed but follows a bivariate normal distribution. Second, the license fees that the downstream cable operator pays to the upstream TV channels are not exogenously determined, but are endogenously negotiated and determined by these two parties via Nash bargaining. We numerically simulate the equilibria of no bundling, mixed bundling and pure bundling, and find that pure bundling flattens viewers' demand, and enables the monopolistic cable operator to extract more surplus from consumers. However, if the upstream networks and the downstream cable operator are allowed to bilaterally negotiate the license fees, license fees will be higher (lower) under pure bundling, depending on whether the cable operator has mass (niche) market demand. Advertisement plays a very important role. By incorporating advertisement in our model, we find that it is possible that pure bundling strictly dominates mixed bundling. Our paper also discusses the welfare implications of an
a la carte regulation. In our benchmark model, we show that an a la carte regulation will benefit consumers and hurt the cable operator. However, when incorporating advertisement and license fees in our model, consumers may be worse off, while the cable operator may benefit from an a la carte regulation. Therefore, our paper can provide a second thought about the advocation for an a la carte regulation in cable TV industry. Our model, using the TV industry as a motivating example, can be easily applied to other markets that share similar features. It can also be extended to the cases where both sides of groups receive positive externalities from the other (as opposed to one receiving negative externalities, like the viewers in our model).
3. A la Carte Cable and the Market for Advertisement

3.1 Introduction

The debates on whether the government should impose an a la carte regulation on cable industry have received increasing attention. Consumer groups and politicians argue that bundling TV channels together contributes to the tremendous increase of the cable price. They ask FCC to regulate this industry and force cable and satellite operators to offer channels a la carte and allow consumers to choose purchasing only the TV channels they want. However, cable interest groups argue that if cable operators respond to a la carte regulation by increasing the price for each individual channel, consumers’ total bill for cable may go up with fewer channels. Therefore, they argue that a la carte pricing will hurt consumers. The attitude of FCC is ambiguous. In its first report in 2004, it concluded that an a la carte regulation will reduce economy of scale, increase the transaction cost, therefore increase the price of channels. This regulation would be of little benefit to consumers (FCC (2004)). However, its second report in 2006, reversed many of its arguments in the previous report and conclude that consumers may, in fact, substantially benefit from an a la carte regulation (FCC (2006)).

A rich theoretical literature on bundling shows that bundling can reduce consumers' heterogeneity and flatten the demand curve. Crawford and Cullen (2007) and Bakos and Brynjolfsson (1999) show how bundling flattens the demand curve. Figure 1 exhibits the demands for a bundle of 2 goods and a bundle of 20 goods when the demand for one good is normally distributed with mean equal to 2 and variance 1. The blue curve represents the demand for one good, and the green curve is the willingness-to-pay (WTP) for one good under bundling where we assume consumers’ WTP can be equally divided among the products in the bundle. As the bundle size grows, the demand curve becomes flatter progressively because the number of consumers with extreme preference decreases. Facing a flatter demand curve, the monopolist is able to extract more surplus from consumers (Schmalensee
Bakos and Bryjolfsson (1999) show that bundle profit converges to total surplus as bundle size increases without bound if the marginal costs for bundled components are zero.

The purpose of this paper is to empirically investigate the effects of an a la carte regulation in cable TV industry using the results from a cable demand estimation model, which help quantify the benefits and costs from a proposed a la carte regulation. Households’ decision on TV watching can be divided into two steps: (1) what package to purchase; (2) conditional on the package subscription, which channels to watch. In the estimation of households’ television-watching decision, we formally incorporate the advertisement in the model to see how advertisement may affect the ratings of channels, that is, does the advertisement on TV channels affect viewers’ stickiness to a channel? Or will audience switch to other channels if there is too much advertisement? Besides the channel characteristics, different advertisement level is an important source to explain the different rating between channels.

This paper also investigates what factors affect advertisers’ demand for advertising on television. Since 1970s, the volume of TV advertisement has increased tremendously. The TV ad expenditure increased from around $1,600 millions in 1960 to 71,000 millions in 2007\(^1\). Out of all advertising mediums, television remains one of the most important. The share of the TV ad expenditure out of total ad expenditure increased from less than 14% in 1960 to more than 25% in 2007\(^2\). Advertisers advertise on TV programs to deliver the information about their products to viewers, and it would be worthwhile to investigate how the number of viewers influences the demand for advertisement. Our paper estimates an aggregate inverse demand function for advertising on channels.

We conduct a full a la carte counterfactual simulation to investigate the policy implication when cable and satellite operators are forced to offer the most 10 popular TV channels a la carte. To do this, we first recover the license fees that cable/satellite operators pay to TV channels and the other marginal cost that cable operators have to run the package. We

\(^{1}\)Sources: Universal McCann, reported at www.tvb.org.
\(^{2}\)Sources: Universal McCann, reported at www.tvb.org.
assume that the license fees are determined via bilaterally negotiation of an upstream TV
network and downstream TV channels. We then use the estimated license fees to estimate
the prices for these 10 channels. In current counterfactual estimation, we assume that the
license fees remain at the level before an a la carte regulation. We also assume that the an
a la carte regulation will not affect the advertising level as well.

3.1.1 Literature review

There are many empirical works examining the short run welfare effect of a la carte pric-
ing in cable television industry. Byzalov (2008), Crawford and Yurukoglu (2008), Rennhoff
and Serfes (2008) and Yurukoglu (2008) assume that consumers’ valuation of a bundle of
channels is the utility from watching those channels. Byzalov (2008) uses individual-level
data (from Simmons Research) of cable/satellite subscriptions and viewership for 64 main
cable channels to estimate consumers’ utility from a bundle. If cable companies are forced
to break up the bundle into 7 themed tiers by channel genre, consumers cannot benefit too
much from a la carte. The license fee per subscriber may increase becasue there may be a
significant drop in the number of subscribers. Rennhoff and Serfes (2008) explicitly model
the strategic interactions between cable operators and cable TV networks on the license fee.
They find that consumer welfare increases unambiguously under a la carte pricing because
the expected monthly expenditure per household falls by more 15 percent.
Crawford and Yurukoglu (2008) and Yurukoglu (2008) both decompose the utility from
bundle into two steps. First, conditional on subscribing the bundle, they use the market-level
data on how households allocate their leisure time to channels to estimate consumers’ utility
from watching the channels they have purchased. Second, they deduct households’ disutility
of paying for the bundle and the total utility from bundle. Crawford and Yurukoglu (2008)
then conduct a counterfactual simulation which forces cable companies to offer the channels
separately and charge prices for each individual component, while Yurukoglu (2008) allows
for the the negotiation of supply contracts between the cable TV networks and cable com-
panies. None of the above works explicitly model advertisement in viewers’ utility function
and examine the effect of advertisement on viewers’ utility. Wilbur (2008) proposes a two-sided model of television industry. On one hand, he estimates how the advertising units affect viewers’ demand and, on the other hand, estimates how the audience size influences advertisers’ demand. By using the data of 6 US broadcast television networks, he finds that viewers tend to be advertisement averse.

Our paper combines these two streams of literature together, and explicitly incorporate advertisement level in viewers utility function to investigate how advertisement affects viewers’ watching behavior. We also test how audience size affects advertisers’ demand for advertisement. Put differently, we examine the two-sidedness of television industry. Moreover, this paper also examines the policy implications that cable and satellite operators are forced to offer TV channels a la carte.

3.2 Data

Three categories of data are used: (i) the data of television programming services, which measure viewers’ package purchasing behavior; (ii) viewership data (rating), which measure viewers’ preference on channels; and (iii) the advertising data, which tell us the advertising unit and price on each channel.

The data of television programming services are from the Television and Cable Factbook. The main data in the Television and Cable Factbook are the number of television programming services (cable and satellite television packages) provided, the monthly fees and the market shares of these services. The Factbook also provides the information of channel composition in a particular cable service, the homes passed which can be used to measure the market size of each service, and other characteristics of cable/satellite services. In this paper, we use all television programming systems in May, 2005 across 46 DMAs. Descriptive statistics for these services are reported in table B.17.

The viewership data and the advertising data are both from Nielsen Media Research. The viewership data contain local ratings and projections (estimated viewers in thousands) for 29 selected cable networks during the primetime for May 2005 (from April 28 to May 25). The
rating is the share of the households with television in the DMA viewing the channels. Data cover 46 DMA markets. The local rating shows the share of universal TV households who tuned to a program in the given time period. Observations are recorded by following the pattern of channel-market-day. The local rating based on the days in a week and channels are reported in table B.18.

The variables in advertising data include: total advertisement units, GRP (gross rating point), and the estimated cost per thousand (CPM) for all advertisements airing on 29 national cable networks during the primetime in May 2005. One unit of advertisement is a piece of advertisement that is aired with the length of either 15 seconds, 30 seconds or 60 seconds. The number of advertisement for each channel is measured by the average advertisement unit within 30 minutes of programs during the primetime. GRP is the proxy of audience size. It is used to measure the exposure to one or more programs and commercials, without regard to multiple exposures of the same advertising to individuals. CPM measures advertisers’ cost per thousand viewers who are exposed to a commercial. The total cost for one or a series of commercials is divided by the projected audience in thousands. Descriptive statistics for these services are reported in table B.19.

Besides these three primary categories, the data of program characteristics are also used in estimations. Program characteristics are hand-collected by the authors. We divide the programs aired during the sample period into 22 genres: comedy_show, csi, documentary, reality, sitcom, drama, kids_show, law_order, movie_action, movie_comedy, movie_crime, movie_drama, movie_horror, movie_thriller, movie_western, music, news, food, sports_baseball, sports_basketball, sports_wrestling, and sports_other. Since each observation of the local rating data is recorded as channel-market-day and we don’t have the rating based on the program level, the value of these program characteristics is in percentage. For example, the programs on AEN during the primetime on April 28, 2005 are: 8:00-10:00 pm “Cold Case Files” and 10:00-11:00 pm “The First 48”. The first program belongs to the genre of “documentary” and the second to the genre of “drama”. Then we record the program characteristics for AEN on April 28 as 66.67% in “documentary” and 33.33% in “drama”.
3.3 Model

In this section, we present a model of agent behavior. We formally model households’ decisions regarding television-watching and cable package choices, programming operators’ pricing decisions, and television channels’ advertisement pricing decisions. We begin with households’ viewing and purchasing decisions.

3.3.1 Households demand model

In our model, households face two interconnected decisions: which cable/satellite package to purchase and, conditional upon that choice, which channel to watch. The choices are interconnected because a household’s cable package determines the choice set they face when deciding what to watch and, conversely, their likely viewing choices impact which cable/satellite package they purchase. Below, we present a model that captures both elements of this relationship.

Television viewing choices

We begin with a simple random coefficient logit model of viewing choice by allowing for individual-specific deviation for the preference of advertisement\(^3\). Conditional on the subscription of a certain television programming service, we assume that households, on any given night, choose to watch the channel that yields the highest utility. Households may also select to forgo watching television on certain days. The utility that household \(i\) in market \(m\) receives from watching channel \(j\) on day \(t\) is given as follows:

\[
\begin{align*}
u_{ijmt} &= X_{jmt}\beta + q_{jt}(\alpha + \eta_i) + \xi_{jmt} + \epsilon_{ijmt} \\
&= \delta_{jmt} + q_{jt}\eta_i + \epsilon_{ijmt}
\end{align*}
\]  

(3.1)

where \(X_{jmt}\) is a vector of observable characteristics for channel \(j\) (e.g. the genre of shows on channel \(j\) during a given day, market, and the day-of-week dummies), \(q_{jt}\) is the aggregate

\(^3\)In future versions of the paper, we intend to allow for greater heterogeneity by adopting a random coefficients logit specification.
amount of national advertising on channel \( j \) during day \( t \). \( \xi_{jt} \) captures unobserved product characteristics of channel \( j \), and \( \alpha \) and \( \beta \) are viewers’ taste parameters. \( \eta_i \) is a random draw for individual \( i \). Here, we modify Cohen (2008) by assuming that the individuals have nonnegative deviation on the preference of advertisement. More specifically, \( \eta_i \) measures viewers’ maximum disutility from advertising which is common to all viewers and \( \alpha + \eta_i \) is the total disutility from advertising. We may define \( d_{jmt} \) as the mean utility from channel \( j \) in market \( m \) on day \( t \). Finally, \( \epsilon_{ijmt} \) is viewer \( i \)’s idiosyncratic error term and is distributed type I extreme value.

Given the specification in equation (3.1), we can derive the probability that household \( i \) watches channel \( j \) on day \( t \), conditional on receiving television programming package \( k \), as follows:

\[
s_{jmt|k} = \frac{e^{\delta_{jmt} + q_j \eta_i}}{1 + \sum_c \text{in } k e^{\delta_{cmt} + q_c \eta_i}}
\]  

(3.2)

While equation (3.2) expresses the probability that a household with package \( k \) watches channel \( j \), Nielsen channel viewing reports give aggregate totals per market. In order to match the market-level Nielsen data, we must aggregate viewer shares over all television programming providers and all offered programming packages. In each market \( m \), there are cable and satellite operators offering a number of different television programming packages. For example, cable television providers such as Comcast offer both "basic" and "expanded basic" programming options in a variety of markets. At the aggregate level, the share of households watching channel \( j \) depends on which packages this channel is included in and the probability of households subscribing to these packages. Accounting for this, we can write the percentage of the population in market \( m \) watching channel \( j \) on day \( t \) \( (s_{jmt}) \) as:

\[
s_{jmt} = \sum_{k \text{ cont.} j} (s_{jmt|k} * S_{km})
\]  

(3.3)

where \( s_{jmt|k} \) is the share of households with package \( k \) that derive the highest utility

---

4We are also implicitly assuming in equation (3.2) that programming package \( k \) contains channel \( j \). Household subscripts are not necessary in equation (3.2) because of our assumption of homogeneity of preferences.
from watching channel \( j \) and \( S_{km} \) is the share of households in market \( m \) who subscribe to programming package \( k \).

**Programming package choice**

The utility that a household receives from watching the included channels helps determine the likelihood of purchasing a given programming package. We define this utility term as a household’s daily average expected maximized utility aggregated over all days. Mathematically, this expected television watching utility \( (W_{km}) \) can be written:

\[
W_{km} = \sum_{t=1}^{T} \left[ \log \left( \sum_{cink} \exp (\delta_{cmt} + q_{jt} \eta_i) \right) \right]
\] (3.4)

The programming package subscription decision also depends on a variety of other factors, such as the disutility from the package’s price or the total number of channels offered in a given package. Assume that there are \( K \) programming packages offered in market \( m \). In each market, there are two television programming operators, which we index with \( n \): a local cable monopolist and a satellite television provider.\(^5\) Each household must decide whether to purchase one of these \( K \) packages or forgo receiving access to television channels (aside from those available over-the-air). Household \( i \)'s utility from purchasing package \( k \) provided by programming operator \( n \) in market \( m \) is given by:

\[
U_{iknm} = W_{km} + Z_{knm} \kappa - \gamma P_{knm} + \eta_{knm} + e_{iknm} = \omega_{knm} + e_{iknm}
\]

where \( W_{km} \) is the utility that household \( i \) expects to receive from watching the channels included in package \( k \), \( Z_{knm} \) is a vector of programming package characteristics (ex. operator dummies, number of channels in package \( k \)), \( P_{knm} \) is the monthly price of package \( k \), \( \eta_{knm} \) represents unobserved characteristics of package \( k \), \( e_{iknm} \) is an idiosyncratic error term distributed type I extreme value, and \( \kappa \) and \( \gamma \) are parameters to be estimated. The assumption

\(^5\)In our model \( K-1 \) of these packages are offered by the local cable monopolist. Due to limitations in data availability, we assume that the satellite provider offers only one programming package, which we proxy using DirecTV's Choice package.
regarding $e_{iknm}$’s distribution allows us to derive the market share of each package $k$ as:

$$S_{km} = \frac{e^{\omega_{km}}}{1 + \sum_{b}^{K} e^{\omega_{bkm}}}$$

3.3.2 Programming operator profit maximization

Programming operators purchase channels from the television network owners, such as Time Warner, and then package and sell them to households. Programming operator $n$’s profit from package $k$ in market $m$ is:

$$p_{down}^{knm} = S_{knm}M_{m}(P_{knm} - \sum_{all \ j \ in \ k} r_{j} - c_{knm}) \quad (3.5)$$

where $P_{knm}$ is the price of the package $k$ in market $m$ by operator $n$. $r_{j}$ is the (per-subscriber) license fee that the programming operator pays to the owner of channel $j$. $c_{knm}$ is the marginal cost (except the license fees for the 29 sample channels in our data) for programming operators to carry package $k$. If programming operator $n$ offers $K_{nm}$ packages in market $m$, then $n$’s total profit is simply the summation of all package profit:

$$\Pi_{nm} = \sum_{k}^{K_{nm}} p_{knm} \quad (3.6)$$

Programming operators choose the price for each of their $K_{nm}$ packages in order to maximize their total profit. The corresponding first order condition can be written as follows:

$$\frac{\partial \Pi_{nm}}{\partial P_{knm}} = \sum_{z}^{K_{nm}} \frac{\partial \pi_{znm}}{\partial P_{knm}} = 0 \quad (3.7)$$
where

\[
\frac{\partial \pi_{knm}}{\partial P_{knm}} = S_{knm}M_m + \frac{\partial S_{knm}}{\partial P_{knm}} M_m (P_{knm} - \sum_{all \ j in knm} r_j - c_{knm}) \\
= S_{knm}M_m - \gamma S_{knm} (1 - S_{knm}) M_m (P_{knm} - \sum_{all \ c \ in \ knm} r_j - c_{knm})
\]

\[
\frac{\partial \pi_{znm}}{\partial P_{knm}} = \frac{\partial S_{znm}}{\partial P_{knm}} M_m (P_{znm} - \sum_{all \ j in \ znm} r_j - c_{knm}) \\
= \gamma S_{znm} S_{knm} M_m (P_{znm} - \sum_{all \ j in \ znm} r_j - c_{knm})
\]

The solution to this system of first order conditions characterizes the optimal programming package price vector.

### 3.3.3 Advertiser demand

Advertisers value the air-time during particular programs based on factors such as the audience size and viewers’ demographics. Following Wilbur (2008), we assume that the aggregate inverse demand for advertising on a given channel and day is given by:

\[
p_{jt} = q_{jt}\lambda + V_{jt}\theta + Y_{jt}\eta + \mu_{jt}
\]  

(3.8)

where \( p_{jt} \) is the price of advertising at channel \( j \) on day \( t \), \( V_{jt} \) is the total number of viewers watching channel \( j \) on day \( t \) (in all markets)\(^6 \), and \( Y_{jt} \) is a vector of characteristics of channel \( j \), \( \lambda, \theta \) and \( \eta \) are advertisers’ preference parameters, and \( \mu_{jt} \) is an error term

### 3.3.4 Television networks

Television networks receive revenue from two sources. They charge per-subscriber license fees to programming operators and they also sell a number of advertising slots during their network programming to advertisers. The profit function of channel \( j \) is given as follows:

\[
p_{j}^{up} = \sum_{all \ t} (q_{jt}\lambda + V_{jt}\theta + Y_{jt}\eta)q_{jt} + \sum_{all \ m} M_m (S_{all \ n}(S_{knm} * r_{jn})
\]

(3.9)

\(^6\) \( V_{jt} = \sum_{all \ m} V_{jmt} = \sum_{all \ m}(M_m * s_{jmt}) \)
The first term in equation (3.9) is the profit that the television network owner receives from advertisement. The second term in equation (3.9) represents the profit generated by charging license fees to programming operators. Mathematically, the second term is equal to the total number of subscribers in all markets multiplied by the per subscriber license fee.

Television network owner’s profit is the summation of equation (3.9) over all of the channels they own.

\[ \Pi_{up} = \sum_{\text{all } c \text{ belongs to } n} \left( \sum_{\text{all } t} (q_{ct} + V_{ct} + Y_{ct} - mc_{ct})q_{ct} + \sum_{\text{all } m} M_{m}(S_{all n}(S_{cnm} * r_{cn})) \right) \]

The profit-maximizing problem for a television network owner is quite complex. We can think of modeling it as a three stage game. In the first stage, the network owner chooses its programs. In the second stage, given these programs, the network owner determines its daily programming schedule. Finally, in the third stage, networks choose the amount of advertising to air during each program and the license fee to charge each television programming operator. Following Wilbur (2008), we abstract away from the first two stages and focus solely on the final stage where advertising amounts and license fees are determined.

We assume that television networks will choose the advertisement units to maximize their profit. The first order condition can be written as:

\[ \frac{\partial \Pi_{up}}{\partial q_{jt}} = \sum_{\text{all } c \text{ belongs to } n} \frac{\partial \Pi_{up}}{\partial q_{jt}} = 0 \]

\[ = p_{jt} - mc_{ct} + \lambda q_{jt} + \theta \sum_{m} \left( \frac{\partial V_{jmt}}{\partial q_{jt}} q_{jt} + \sum_{c} \frac{\partial V_{cnt}}{\partial q_{jt}} q_{ct} \right) + \sum_{\text{all } m} M_{m} \left( \sum_{k \text{ cont } j} \frac{\partial S_{knm}}{\partial q_{jt}} r_{jn} \right) \]
where

\[
\frac{\partial \Pi_{\text{net}}}{\partial r_j} = \sum_{\text{all } j \text{ belongs to } T} \left( \sum_{\text{all } j \text{ belongs to } T} \frac{\partial \Pi_{\text{net}}}{\partial r_j} \right) = 0
\]

\[
= \sum_{\text{all } j \text{ belongs to } T} \left( \sum_{\text{all } m} \theta M_m \left( \sum_t s_{jmt|kq_{jt}} \frac{\partial S_{kknm}}{\partial r_j} \right) + \sum_{\text{all } m} M_m \frac{\partial S_{kknm}}{\partial r_j} r_j \right) + \sum_{\text{all } m} M_m S_{kknm}
\]

(3.10)

(3.11)

where

\[
\frac{\partial S_{kknm}}{\partial r_j} = \frac{\partial S_{kknm}}{\partial P_{kcm}} \frac{\partial P_{kcm}}{\partial r_j}
\]

\[
\frac{\partial S_{kknm}}{\partial P_{kcm}} = -\gamma S_{kknm} (1 - S_{kknm})
\]

\[
\frac{\partial P_{kknm}}{\partial r_{jm}} = \frac{1}{(1 + \gamma S_{kknm} (P_{kknm} - \sum_{\text{all } j \text{ in } k} r_j - c_{knm}))}
\]

(3.12)

When the license fee of channel j increases, it will drive up the prices of the packages which include j, and decrease the share of subscription of these packages. As a result, the share of households who choose to watch channel j will be affected, which in turn will affect the TV network’s revenue from advertisement. The first component, \( \sum_{\text{all } m} \theta M_m \left( \sum_t s_{jmt|kq_{jt}} \frac{\partial S_{kknm}}{\partial r_j} \right) \), in (3.11) represents the loss of advertisement revenue when the TV network increases its license fee.

### 3.4 Estimation and identification

#### 3.4.1 Taste preference estimation

The estimation of households’ demand is divided into two steps: First, we estimate viewers’ mean utility, \( \delta_{jmt} \), from viewing channels conditional on the purchase of the bundled package. We conduct this estimation by using the local rating data. In this step, we incorporate the advertising units to estimate how viewers dislike the advertisement. Second, we use the market share of households who purchase different packages to estimate the disutility from the price.
In equation (3.3), the left-hand side is the rating (share of viewing) which is the aggregate data on DMA level. The observed share on the right-hand side is the share of subscription whose unit of observation is cable market. One DMA may include many cable markets. To overcome the inconsistency of two datasets, we transfer these "cable market" observations into DMA-level viewer shares. We replace $S_{km}$ in equation (3.3) with $\sum_{allz} S_{kmz} \ast SIZE_z$, where $SIZE_z = \frac{Pop_z}{\sum k Pop_k}$ and $Pop_z$ is the number of home-passed in cable market $z$. $SIZE_z = 1$ for satellite package.

Substituting (3.2) into (3.3), the predicted viewers' share can be described as follows:

$$\hat{s}_{jmt} = \sum_{j \in k} \left( \sum_{all z} \frac{e^{\delta_{jmt} + \eta_i \eta_i} e^{\delta_{cmt} + \eta_i \eta_i} \ast S_{kmz} \ast SIZE_z} {1 + \sum c in k e^{\delta_{cmt} + \eta_i \eta_i} \ast S_{kmz} \ast SIZE_z} \right)$$

(3.13)

By setting the predicted viewers' share equal to the observed viewers' share from Nielsen data, we can use contraction mapping method, proposed by Berry, Levinsohn, and Pakes (1995) and described in detail by Nevo (2000), to get the mean utility from watching channels: $\delta_{jmt}$. At this moment, we don’t estimate the variance of $\eta_i$ but simply assume that $\eta_i$ follows a certain type of non-negative distribution. The steps to calculate $\delta_{jmt}$ can be described as follows:

1. Prepare random draws of the non-negative individual-specific deviations: $\eta_i$.
2. Use the starting values of $\delta_{jmt}^{old}$ to calculate $\hat{s}_{jmt}$.
3. Update the values of $\delta_{jmt}$ by using $\delta_{jmt}^{new} = \delta_{jmt}^{old} \ast \frac{s_{jmt}}{s_{jmt}}$.
4. Exit the estimation if $s_{jmt} \approx \hat{s}_{jmt}$.

After the viewers’ mean utility from watching channel $j$ in market $m$ at day $t$ has been obtained, we are able to estimate the households’ non-price taste parameters, $\alpha$ and $\beta$, for

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7 We try two types distribution of $\eta_i$: (1) Modify the distribution Cohen (2008), we use the left truncated standard normal distribution. (2) Use the squared standard normal distribution. Both distributions can guarantee non-negative individual-specific deviations. There is no qualitatively different between the results from these two distributions.

8 In the long run, we will adopt more of the BLP-style approach.
TV channels by using the equation below:

\[ \delta_{jmt} = X_{jmt}\beta + q_{jt}\alpha + \zeta_{jmt} \]

In this estimation, the advertising units, \( q_{jt} \), may have the problem of endogeneity, that is, some market specific deviations from mean utility, \( \zeta_{jmt} \), though not observed, are likely to be known by the television channels and taken into account when channels set the advertising units. To overcome this problem, we use the fixed effects of channels and day-of-week. Also, the interactive dummies of channels and day-of-week are included in the estimation. Since we assume that the idiosyncratic error term, \( \epsilon_{iknm} \), is distributed type I extreme value, we can estimate the parameters for the bundle characteristics and the price sensitivity parameter by using the equation:

\[
\log(S_{km}) - \log(S_{0m}) = W_{km} + Z_{knm}\kappa - \gamma P_{knm} + \eta_{knm}
\]

### 3.4.2 Estimation of inverse demand for advertisement

Equation (3.8) is used to estimate the aggregate inverse demand for advertising. The error term, \( \mu_{jt} \), is the unobserved channel and viewer characteristics that affect advertisers’ demand for advertisement, and to have unbiased estimation, there should be no correlation between \( \mu_{jt} \) and the independent variables. However, television channels might partly observe these channel and viewer characteristics and the characteristics might affect channels’ decision on advertisement units. Therefore, the advertisement units, \( q_{ji} \), might be correlated with \( \mu_{jt} \). Since the number of viewers depends on the advertisement units, \( V_{jt} \) might be correlated with \( \mu_{jt} \) as well. To correct the bias in the estimations of \( \lambda \) and \( \theta \), some instruments are used. Following Wilbur (2008), we use the observed show characteristics and non-ad mean utility of the channel as the instruments. The non-ad mean utility is defined as \( \bar{\delta}_{jmt} - q_{jt}\alpha \), where \( \bar{\delta}_{jmt} \) is the average of the utility from channel \( j \) at day \( t \) over 46 DMAs. These instruments enter the equation (3.3) to calculate the percentage of the population who watch each channel, thus these instruments are correlated with the number of viewers.
Because of the two-sidedness of television industry where the number of viewers and advertising level are interdependent with each other, advertisement units $q_{jt}$ is also correlated with these instruments. Therefore the first condition for a feasible instrument, that is, the instrument variables must be correlated with the instrumented variables are satisfied. Next, let’s discuss the irrelevancy between the instruments and the advertisers’ preference for the unobserved channel and audience characteristics. Non-ad mean utility is the viewers’ net mean utility from observed channel characteristics (where viewers’ utility from advertisement is deducted) and these observed channel characteristics are included as the independent factors to explain the advertiser preference, therefore, it is reasonable to assume that non-ad mean utility is independent to the advertiser preference for the unobserved channel and audience characteristics.

3.5 Estimation results

This section discusses the estimated parameters.

$\text{≺ table B.20 ≻}$

Table B.20 reports the estimation of non-random utility coefficients. The independent variables include the show characteristics, day-of-week dummies, channel dummies, market dummies and the interactive dummies of day-of-week and channel. If we assume that individual-specific deviations of the preference for advertisement are positive and distributed standard normal left truncated at zero, $\alpha$, the maximum disutility from advertisement is -1.601. Among 2000 simulated individuals, about 90% of $\alpha_i (= \alpha + \eta_i)$ are negative, which suggests that most of the households dislike advertisement 9.

$\text{≺ table B.21 ≻}$

Table B.21 reports the median of the maximum own-advertising elasticities by channels. The own-advertising elasticities of audience size are calculated to equal $-\alpha \times Unit \times (1 - s_{jmt})$.

9We also conduct the estimation in which we assume that $\eta_i$ is distributed squared standard normal. The result is only quantitatively different. $\alpha = -3.2$ and about 93% of $\alpha_i$ is negative.
All channels are very elastic to advertisement. Among all channels, BET is the most elastic while NICK is the least. When advertisement increases by 1%, the probability of watching BET will decrease by about 26.7%, while NICK will decrease by 6.35%.

Table B.22 reports the coefficients of cable service subscription. In this estimation, we include the monthly fee of each service, cable characteristics dummies and DMA dummies. In a logit model, the own-price elasticities can be calculated by $-\alpha p_j(1 - s_j)$. The price sensitivity parameter is -1.261, which indicates that the average own-price elasticity is -17.51 for Basic cable, -23.26 for Expanded Basic 1, -21.59 for the Expanded Basic 2, and -42.42 for Satellite.

Table B.23 reports the estimates of the inverse demand for advertisement. Variable "unit" is the advertising quantity. The sign of the coefficient of unit is negative (though not significant), which indicates that the higher the advertising level is on a channel, the lower the advertising price is charged. "GRP" measures the audience size. The number of viewers places a positive externality to advertisers. The more viewers a channel has, the higher price this channel can charge from advertisers.

3.6 Counterfactual estimation

In this section, we describe a numerical simulation aimed to quantifying the likely impact of an a la carte regulation. We simulate the equilibrium prices for the 10 most popular channels at the estimated parameters. To do this, we first recover the license fee cost that programming operators pay to TV networks by assuming that license fees are negotiated by a upstream and a downstream firm. Second, we use the estimated license fees and marginal cost to calculate the equilibrium price for each individual channel.
3.6.1 License fees estimation

License fees are determined via bilateral negotiation of a pair of upstream and downstream firms. Each pair of programming operator \( k \) and TV network \( j \) negotiate over the license fee to maximize the Nash product. There are extensive studies on bilateral negotiations. Similar to the environments in Horn and Wolinsky (1988), Hart and Tirole (1990), McAfee and Schwartz (1994), and Segal and Whinston (2003) where there are more than one firm in one side of the market, there are two upstreams in our model. The downstream firm will bargain with each upstream firm (i.e. Comcast-CNN and Comcast-ESPN) separately and simultaneously. The outcome of Comcast from the negotiation with CNN depends the outcome of the negotiation between Comcast and ESPN. We assume that each pair take the outcome from the other pair as given. Each pair of upstream and downstream firms will choose license fee \( r_i \) to maximize the Nash product. The Nash product is defined as follows,

\[
NP_{kj} = (\Pi^Y_k - \Pi^N_k)^\lambda(\Pi^Y_j - \Pi^N_j)^{1-\lambda}
\]

where \( \lambda \) is the downstream firm bargain power. \( \Pi^Y_k \) and \( \Pi^Y_j \) are the profits of the downstream and upstream firms when an agreement is reached. \( \Pi^N_k \) and \( \Pi^N_j \) are the profits of downstream and upstream firms when they cannot reach an agreement with channel \( c \). The FOC of the Nash bargain solution is

\[
\frac{\partial NP_{kj}}{\partial r_j} = \lambda(\Pi^Y_k - \Pi^N_k)^{\lambda-1} \frac{\partial \Pi^Y_j}{\partial r_j} (\Pi^Y_j - \Pi^N_j)^{1-\lambda}
+ (1 - \lambda)(\Pi^Y_k - \Pi^N_k)^{\lambda} (\Pi^Y_j - \Pi^N_j)^{-\lambda} \left( \frac{\partial \Pi^Y_j}{\partial r_j} - \frac{\partial \Pi^N_j}{\partial r_j} \right)
\]  

(3.14)

We use Chicago as an example. In Chicago, there are 5 cable areas and we assume that all cable programs are distributed by the same operator. Therefore, the downstream firm’s profit is equal to the sum of the profits from all cable areas. We assume that the license fee of one channel is exactly the same no matter this channel is in ”Basic” or ”Expanded Basic” package. The estimated license fees are reported at table B.24. The unit of the license fees
in table B.24 is dollar per subscriber. If the programming operator, i.e. Comcast, carries AEN in either package, Comcast needs to pay AEN about $0.095 per subscriber. We only have data of 29 channels and don’t have the carriage information of other channels, therefore, we are not able to recover the license fees for the other channels. Besides license fees, programming operators may have other operation costs, e.g. installation fee etc, which cannot be estimated as well. We estimated an aggregate marginal cost for each cable market to measure all other costs for programming operators. The marginal costs are reported at table B.25.

≺ table B.25 ≻

3.6.2 A la carte prices estimation

In the counterfactual estimation, we still use Chicago as a sample market to estimate the a la carte price offers. Due to the computational complication, we currently are unable to estimated the a la carte offers for all 29 channels. Instead, we will estimate the prices for the 10 most often-seen channels. These 10 channels are: ESPN, FX, FXNC, HIST, LIF, NICK, SPK, TBSC, TNT, and USA. In current version of the estimation, there are two assumptions: First, we assume that license fees remain unchanged with an a la carte regulation. Second, we assume that the advertising levels are unchanged with an a la carte regulation.

In the counterfactual estimation, we assume that there is a cable TV provider and a satellite TV provider. Each household has three choices: buy the cable “bundle” (the set of channels) that they most prefer (conditional upon buying cable), buy the satellite “bundle” they most prefer (conditional upon buying satellite), or buy nothing. Households have deviation in the preference to advertisement (we have 2000 random draws that are assumed to be the absolute value of standard normal distribution). This will allow us to catch the heterogeneity of viewers so that households may prefer different combinations of channels. For each household, we can calculate the utility they receive from each combination of packages and subtract the disutility from price. Let’s use three channels (A,B,C) as examples to describe
household decision. Both satellite and cable offer the same three channels. Taking the prices offered by cable and satellite as given, the basic steps of household decision are:

1. Start with cable (given prices and the preference for advertisement), derive the deterministic utility from the 7 possible choices (A, B, C, AB, AC, BC, ABC).

2. Assume that household #1 “selects” the combination of channels that yields the highest utility. Let us call this “preferred cable combination”.

3. Repeat these steps for satellite. Let us call this “preferred satellite combination”.

4. The end result of steps 1 – 3 is that household #1 has two choices (plus the outside option): the preferred cable combination and the preferred satellite combination.

5. Add in a logit error and calculate the probability of purchasing the preferred cable combination, the preferred satellite combination, and the outside option.

6. Move on to household #2 and repeat steps 1 – 5.

7. Taking the averages of the 2,000 households yields market shares for all channels (and combinations of channels).

Then cable and satellite choose the prices to maximize their profit.

3.7 Conclusion

In this paper, we set up a structural model to test the impact of an a la carte regulation in the cable TV industry. To do this, we empirically estimate viewers’ preference parameters, which give us viewers’ dollar valuation for individual channels. We formally model household decision (regarding television-watching and cable package choices), cable operator pricing decisions and television channel advertisement pricing decisions. In the estimation of household television-watching decisions, we explicitly incorporate advertising in the utility function and find that advertising levels bring negative utility to most of the consumers. We also estimate the inverse demand for advertising on TV channels. Finally, we conduct a full counterfactual simulation to examine how an a la carte regulation will affect the industry.
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Chapter 2 references


Chapter 3 references


Appendix A. Proof of Chapter 1

A.1 Equilibria in one-sided market

A.1.1 Mixed bundling (denoted as OMB)

Viewers’ demand functions are given by,

\[ d^{OMB}_B = V - p^{MB}_B \]
\[ d^{OMB}_a = 1 - p^{MB}_a \]
\[ d^{OMB}_b = 1 - p^{MB}_b \]

Cable operator’s profits is given by,

\[ p^{OMB} = d^{OMB}_B * p^{OMB}_B + d^{OMB}_a * p^{OMB}_a + d^{OMB}_b * p^{OMB}_b \]

Take derivative w.r.t \( p^{OMB}_B, p^{OMB}_a, p^{OMB}_b \) and solve the FOCs, we have,

\[ p^{OMB}_B = \frac{V}{2} \]
\[ p^{OMB}_a = \frac{1}{2} \]
\[ p^{OMB}_b = \frac{1}{2} \]

Substitute prices into profit function, cable operator’s profit is given by,

\[ \pi^{OMB} = \frac{V^3}{4} + \frac{1}{2} \]
Note that in mixed bundling, we must have $p_B^{MB} = p_a^{MB} + p_b^{MB}$, which indicates,

$$V \leq 2$$

### A.1.2 Pure bundling

All types of viewers are served (denoted as OPB)

The demand functions are given by,

$$d_B^{OPB} = V - p_B^{OPB}$$

$$d_a^{OPB} = 1 - p_B^{OPB}$$

$$d_b^{OPB} = 1 - p_B^{OPB}$$

Cable operator’s profits are given by,

$$\pi^{OPB} = (d_B^{OPB} + d_a^{OPB} + d_b^{OPB}) \cdot p_B^{OPB}$$

Take derivative w.r.t $p_B^{OPB}$ and solve the FOC, we have,

$$p_B^{OPB} = \frac{1}{6}V + \frac{1}{3}$$

Therefore, cable operator’s profit are given by,

$$\pi^{OPB} = \frac{1}{12}(V + 2)^2$$

Only high type of viewers are served (denoted as OPH)

The demand functions are given by,

$$d_B^{OPH} = V - p_B^{OPB}$$
Cable operator’s profits are given by,

\[ p_{OPH} = d_{OPH} \times p_{OPH} \]

Take derivative w.r.t \( p_{PB} \) and solve the FOC, we have,

\[ p_{OPH} = (1/2)V \]

Therefore, cable operator’s profit are given by,

\[ \pi_{OPH} = (1/4)V^2 \]

A.1.3 No bundling

All three types of viewers are served (denoted as ONB)

The demand functions are respectively given by,

\[ d_{ONB} = V - p_{ONB} - p_{b} \]

\[ d_{a} = 1 - p_{a} \]

\[ d_{b} = 1 - p_{b} \]

Cable operator’s profit is given by,

\[ p_{ONB} = (d_{ONB} + d_{a}) \times p_{a} + (d_{ONB} + d_{b}) \times p_{b} \]

Take derivative w.r.t \( p_{a} \), \( p_{b} \) and solve the FOCs, we have,

\[ p_{a} = \frac{1}{6}(V + 1) \]

\[ p_{b} = \frac{1}{6}(V + 1) \]
Cable operator’s profit is given by,

\[ \pi^{ONB} = \frac{1}{6}(V + 1)^2 \]

**Only multiple demand type of viewers are served (denoted as ONH)**

In this subgame, if we assume that two networks are symmetric to cable operator, this subgame is exactly the same as the subgame where cable operator offers only price for bundle and serves only the multiple demand type viewer. The cable operator will set the stand alone prices at \( p^a_{NH} + p^b_{NH} = p^B_{PH} \).

### A.2 Comparison of cable operator’s profit

Cable operator’s profits under different subgame are given by,

\[ \pi^{OMB} = \frac{V^2}{4} + \frac{1}{2} \]

\[ \pi^{OPB} = \frac{1}{12}(V + 2)^2 \]

\[ \pi^{OPH} = \frac{1}{4}V^2 \]

\[ \pi^{ONB} = \frac{1}{6}(V + 1) \]

It is easy to see that strategies OPB, OPH and ONB are weakly dominated by OMB, which means in the existing range of OMB, \([1, 2]\), cable operator will choose mixed bundling pricing strategy. When \( V < \sqrt{2} \), we have \( p^{OPB} > p^{ONB} \), and when \( V < 2 + \sqrt{6} \), we have \( p^{ONB} > p^{OPH} \). Therefore, when \( 2 < V \leq 2 + \sqrt{6} \), cable operator chooses no bundling strategy serving all three groups viewers, and when \( V > 2 + \sqrt{6} \), cable operator will choose to serve only multiple demand group of viewers either by offering a price for bundle or by offer prices for each network.
A.3 Equilibria in two-sided market

A.3.1 Mixed bundling (denoted as MB)

In viewers part, the respective demand functions are given by,

\[ d^\text{MB}_B = V - t \alpha^\text{MB}_a - t \alpha^\text{MB}_b - p^\text{MB}_B \]
\[ d^\text{MB}_a = 1 - t \alpha^\text{MB}_a - p^\text{MB}_a \]
\[ d^\text{MB}_b = 1 - t \alpha^\text{MB}_b - p^\text{MB}_b \]

Cable operator’s profits are given by,

\[ p^\text{MB} = d^\text{MB}_B \ast p^\text{MB}_B + d^\text{MB}_a \ast p^\text{MB}_a + d^\text{MB}_b \ast p^\text{MB}_b \]

Take derivative w.r.t \( p^\text{MB}_B, p^\text{MB}_a, p^\text{MB}_b \) and solve the FOCs, we have,

\[ p^\text{MB}_B = \frac{V - t \alpha^\text{MB}_a - t \alpha^\text{MB}_b}{2} \]  \hspace{1cm} (A.1)

\[ p^\text{MB}_a = \frac{1 - t \alpha^\text{MB}_a}{2} \]
\[ p^\text{MB}_b = \frac{1 - t \alpha^\text{MB}_b}{2} \]

Substitute into the demand functions, we can derive viewers’ demands as functions of advertising levels,

\[ d^\text{MB}_B = \frac{1}{2} V - \frac{1}{2} t \alpha^\text{MB}_a - \frac{1}{2} t \alpha^\text{MB}_b \]  \hspace{1cm} (A.2)
\[ d^\text{MB}_a = \frac{1}{2} V - \frac{1}{2} t \alpha^\text{MB}_a \]
\[ d^\text{MB}_b = \frac{1}{2} V - \frac{1}{2} t \alpha^\text{MB}_b \]
TV networks' implicit demand functions are given by (assuming that TV networks are independent to advertisers),

\[ a_a^{MB} = (d_B^{MB} + a_a^{MB}) - g_a^{MB} \]

\[ a_b^{MB} = (d_B^{MB} + a_b^{MB}) - g_b^{MB} \]

Substitute \( d_B^{MB} \) and \( d_a^{MB} \) into the implicit demand functions, we can solve for the explicit demand functions for advertisement,

\[ a_a^{MB} = \frac{2V + 2 + t - 4g_a + tV - 4tg_a + 2tg_b}{3t^2 + 8t + 4} \] (A.3)

\[ a_b^{MB} = \frac{2V + 2 + t - 4g_b + tV - 4tg_b + 2tg_a}{3t^2 + 8t + 4} \]

Solve for \( g_a^{MB} \) and \( g_b^{MB} \),

\[ g_a^{MB} = \frac{(1 + V)(t + 2)}{2(3t + 4)} \]

\[ g_b^{MB} = \frac{(1 + V)(t + 2)}{2(3t + 4)} \]

The SPNE is given by,

\[ a_a^{MB} = a_b^{MB} = \frac{2(1 + t)(1 + V)}{(3t + 2)(3t + 4)} \]

\[ p_a^{MB} = p_b^{MB} = -\frac{7t^2 + 2t^2V - 16t + 2tV - 8}{2(3t + 2)(3t + 4)} \]

\[ p_B^{MB} = \frac{5t^2V - 4t^2 + 14tV - 4t + 8V}{2(3t + 2)(3t + 4)} \]

Cable operator's profits are given by,

\[ p^{MB} = \frac{1}{4(3t + 2)^2(3t + 4)^2} \left( 114t^4 + 33t^4V^2 - 96t^4V - 336t^3V + 156t^3V^2 + 480t^3 + 284t^2V^2 + 752t^2 - 368t^2V - 128tV + 224tV^2 + 512t + 128 + 64V^2 \right) \]
TV networks’ profits are given by,

\[ \varphi_a^{MB} = \varphi_b^{MB} = \frac{(t + 2)(1 + V)^2(1 + t)}{(3t + 2)(3t + 4)^2} \]

Consumer surplus is given by,

\[ CS^{MB} = \frac{1}{8(3t + 2)(3t + 4)^2} \left(-96Vt^4 + 33V^2t^4 + 114t^4 - 336V^2t^3 + 156V^2t^3 + 480t^3 + 752t^2 \\
+ 284t^2V^2 - 368t^2V + 512t - 128tV + 224tV^2 + 128 + 64V^2) \right] \]

Note that in mixed bundling, we must have \( p_a^{MB} = p_b^{MB} = p_a^{MB} + p_b^{MB} \), which indicates,

\[ \frac{11t^2 + 20t + 8}{7t^2 + 16t + 8} \leq V \leq a = 2 \quad (A.4) \]

### A.3.2 Pure bundling (All types viewers are served denoted as PB)

The demand functions are given by,

\[ d_B^{PB} = V - t\alpha_a^{PB} - t\alpha_b^{PB} - p_B^{PB} \]

\[ d_a^{PB} = 1 - t\alpha_a^{PB} - p_B^{PB} \]

\[ d_b^{PB} = 1 - t\alpha_b^{PB} - p_B^{PB} \]

Cable operator’s profits are given by,

\[ p^{PB} = (d_B^{PB} + d_a^{PB} + d_b^{PB}) * p_B^{PB} \]

Take derivative w.r.t \( p_B^{PB} \) and solve the FOC, we have,

\[ p_B^{PB} = \frac{1}{6} V - \frac{1}{3} t\alpha_a^{PB} - \frac{1}{3} t\alpha_b^{PB} + \frac{1}{3} \quad (A.5) \]
Substitute into demand functions, we can derive viewers’ demands as functions of advertising level,

\[
d_B^{PB} = \frac{5}{6}V - \frac{2}{3}t\alpha_a^{MB} - \frac{2}{3}t\alpha_b^{MB} - \frac{1}{3} \\
d_a^{PB} = \frac{2}{3} - \frac{2}{3}t\alpha_a^{MB} + \frac{1}{3}t\alpha_b^{MB} - \frac{1}{6}V \\
d_b^{PB} = \frac{2}{3} - \frac{2}{3}t\alpha_b^{MB} + \frac{1}{3}t\alpha_a^{MB} - \frac{1}{6}V
\]

TV networks’ demand functions are given by (assuming that TV networks are independent to advertisers),

\[
\alpha_a^{PB} = (d_B^{PB} + d_a^{PB}) - g_a^{PB} \\
\alpha_b^{PB} = (d_B^{PB} + d_b^{PB}) - g_b^{PB}
\]

Substitute \(d_a^{PB}, d_b^{PB}\) and \(d_B^{PB}\) into the implicit demand functions, we can solve for the explicit demand functions for advertisement,

\[
\alpha_a^{PB} = \frac{1 + 2tV - 4tg_a + tg_b + 2V - 3g_a + t}{5t^2 + 8t + 3} \\
\alpha_b^{PB} = \frac{1 + 2tV - 4tg_b + tg_a + 2V - 3g_b + t}{5t^2 + 8t + 3}
\]

Solve for \(g_a^{PB}\) and \(g_b^{PB}\),

\[
g_a^{PB} = \frac{(2V + 1)(t + 1)}{6 + 7t} \\
g_b^{PB} = \frac{(2V + 1)(t + 1)}{6 + 7t}
\]

The optimal advertisement levels and subscription fee in this sub-game are given by,

\[
\alpha_a^{PB} = \alpha_b^{PB} = \frac{(2V + 1)(4t + 3)}{(5t + 3)(6 + 7t)} \\
p_B^{PB} = \frac{18t^2 + t^2V + 30t + 9tV + 6V + 12}{2(5t + 3)(6 + 7t)}
\]
Cable operator’s profits in this equilibrium are given by,

\[ \pi_{PB} = \frac{3(18t^2 + t^2V + 30t + 9tV + 6V + 12)^2}{4(5t + 3)^2(6 + 7t)^2} \]

TV networks’ profits are given by,

\[ \phi^a_{PB} = \phi^b_{PB} = \frac{(2V + 1)^2(t + 1)(4t + 3)}{(5t + 3)(6 + 7t)^2} \]

Consumers surplus is given by,

\[ CS^{PB} = \frac{3}{8(5t + 3)^2(6 + 7t)^2}(-1836t^4V + 1676t^4 + 649t^4V^2 - 5328Vt^3 + 2178t^3V^2 + 4824t^3 \]
\[ + 2757t^2V^2 + 5172t^2 - 5652tV - 2592V + 1548V^2 + 2448t + 432 - 432V + 324V^2) \]

To ensure that all three types of viewers are served, we must have the demand in small demand type to be non-negative, which indicates,

\[ d^P_B = 1 - ta^P_B - p_{PB} > 0 \iff V < b = \frac{2(12 + 22t^2 + 33t)}{17t^2 + 21t + 6} \]  

\( b > 2 \) for all \( t > 0 \).

**A.3.3 No bundling (All types are served denoted as NB)**

In viewers part, the demand functions are respectively given by,

\[ d^N_B = V - t\alpha^N_B - t\alpha^N_B - p^N_A - p^N_B \]
\[ d^N_A = 1 - t\alpha^N_B - p^N_A \]
\[ d^N_B = 1 - t\alpha^N_B - p^N_B \]
Cable operator’s profits are given by,

\[ \pi^{NB} = (d_B^{NB} + d_a^{NB}) \cdot p_a^{NB} + (d_B^{NB} + d_b^{NB}) \cdot p_b^{NB} \]

Take derivative w.r.t \( p_a^{NB}, p_b^{NB} \) and solve the FOCs, we have,

\[ p_a^{NB} = \frac{1}{6}V - \frac{1}{2}t \alpha_a^{NB} + \frac{1}{6} \]
\[ p_b^{NB} = \frac{1}{6}V - \frac{1}{2}t \alpha_b^{NB} + \frac{1}{6} \]

TV networks’ demand functions are given by (assuming that TV networks are independent to advertisers),

\[ \alpha_a^{NB} = (d_B^{NB} + a_a^{NB}) - g_a^{NB} \]
\[ \alpha_b^{NB} = (d_B^{NB} + a_b^{NB}) - g_b^{NB} \]

Solve for \( g_a^{NB} \) and \( g_b^{NB} \),

\[ g_a^{NB} = \frac{(1 + V)(2 + t)}{2(3t + 4)} \]
\[ g_b^{NB} = \frac{(1 + V)(2 + t)}{2(3t + 4)} \]

The optimal advertisement levels and subscription fee in this sub-game are given by,

\[ e_a^{NB} = e_b^{NB} = \frac{2(1 + V)(t + 1)}{(3t + 2)(3t + 4)} \]
\[ p_a^{NB} = p_b^{NB} = \frac{(3t^2 + 12t + 8)(1 + V)}{6(3t + 2)(3t + 4)} \]

Cable operator’s profits are given by,

\[ \pi^{NB} = \frac{(3t^2 + 12t + 8)^2(1 + V)^2}{6(3t + 2)^2(3t + 4)^2} \]
TV networks’ profits are given by,

\[ \varphi^N_B = \varphi^N_a = \frac{(2 + t)(1 + V)^2(t + 1)}{(3t + 2)(3t + 4)^2} \]

Consumer surplus is given by,

\[ CS^N_B = \frac{1}{4(3t + 2)(3t + 4)^2} \left( 57t^4V^2 - 210Vt^4 + 219t^4 + 888t^3 + 240t^3V^2 - 816Vt^3 - 1120V^2t \right. \\
+ 376t^2V^2 + 1312t^2 + 1256tV^2 - 64tV + 832t + 64V^2 - 128V + 192 \]

To ensure that all three types viewers are served, we must have the demand in small demand type to be non-negative, which indicates,

\[ d^N_B = 1 - t\alpha^N_B - p^N_B \geq 0 \iff V \leq d = \frac{39t^2 + 84t + 40}{15t^2 + 24t + 8} \quad (A.8) \]

Note that \( d > 2 \) for all \( t > 0 \).

**A.3.4 Comparison of candidate equilibria**

\[ p^M_B - p^N_B = (V - 2)^2/12, \] which indicates that NB is a weakly dominated strategy to MB for the downstream monopolist, therefore, when \( V = 2 \), we will have two equilibria, MB equilibrium and PB equilibrium. Note that when \( V = V_1 \), we have \( p^M_B = p^P_B \), where \( V_1 \) is given as follows,

\[ V_1 = (1103120t^5 + 69120t + 315877t^6 + 658577t^6 + 6912 + 743760t^3 + 220656t^7 + 300960t^2 \\
+ 1138620t^4 + 2t(6 + 7t)(4 + 3t)(5t + 3)(324t^5 + 1845t^4 + 3876t^3 + 3878t^2 + 1884t + 360)^\frac{1}{2} \\
(3t + 2)^2/(294336t^2 + 697440t^3 + 69120t + 904204t^5 + 495367t^6 + 151782t^7 + 20091t^8 \\
+ 1005836t^4 + 6912) \]

It is easy to see that \( V_1 > \frac{11t^2 + 20t + 8}{7t^2 + 10t + 8} \) for all \( t \) and \( V_1 \leq 2 \) iff \( t \leq 2.3 \). Therefore, if \( t \leq 2.3 \), when \( 2 \geq V \geq V_1 \), we have mixed bundling equilibrium. If \( t > 2.3 \), mixed bundling equilibrium
A.4 Discussion of how \( g_a \) affects \( \alpha_a \) in both PB and MB subgames

Take partial derivative of \( \alpha_a \) with respect to \( g_a \) in (1.3) and (1.4),

\[
\frac{\partial \alpha_a}{\partial g_a} = \frac{\partial D_a}{\partial a} \frac{\partial \alpha_a}{\partial g_a} + \frac{\partial D_a}{\partial \alpha_a} \frac{\partial \alpha_a}{\partial g_a} - 1 \tag{A.9}
\]

Where \( \frac{\partial \alpha_b}{\partial g_a} \) can be get from network b’s demand function for advertisement.

\[
\frac{\partial \alpha_b}{\partial g_a} = \frac{\partial D_b}{\partial \alpha_a} \frac{\partial \alpha_a}{\partial g_a} + \frac{\partial D_b}{\partial \alpha_b} \frac{\partial \alpha_b}{\partial g_a} \Rightarrow \tag{A.10}
\]

\[
\frac{\partial \alpha_b}{\partial g_a} = \frac{1}{1 - \frac{\partial D_b}{\partial \alpha_b}} \cdot \frac{\partial \alpha_b}{\partial \alpha_a} \frac{\partial \alpha_a}{\partial g_a}.
\]

Solve for \( \frac{\partial \alpha_b}{\partial g_a} \), we have

\[
\frac{\partial \alpha_b}{\partial g_a} = \frac{1}{1 - \frac{\partial D_a}{\partial \alpha_a} \frac{\partial \alpha_a}{\partial g_a} + \frac{\partial D_b}{\partial \alpha_b} \frac{\partial \alpha_b}{\partial g_a}}.
\]

There are three effects on the demand for advertisements. The last component of the equation (A.9) reflects the direct effect. When advertisement fee increases by 1 unit, the advertisement level will decrease by 1 unit. The direct effect is the same in both PB and MB subgames. The other two components of (A.9) reflect the indirect effects of advertising fee through the number of viewers \( D_a \) on the demand for advertisement. The first indirect effect is via the network’s own advertising level, \( \frac{\partial D_a}{\partial \alpha_a} \frac{\partial \alpha_a}{\partial g_a} \). When advertising fee increases, it will cause a lower advertising level directly, which further to increase the total viewers and in turn a higher demand for advertisement. As we discuss in section 1.4.1, this effect weakens the direct effect and makes the advertising level decrease slowly. The effect of advertising level on the number of viewers of the same network is more significant in MB.

The second indirect effect is via the advertising level of the network’s competing rival. When channel a increases its advertising fee, it will affect its rival’s advertising level and then the total number of viewers. The key question over here is how the advertising fee would affect its rival’s advertising level. We answer this by taking the partial derivative of \( \alpha_b \) with respect to \( g_a \). From equation (A.10), we know that there are two sources on how the change of
advertising fee on network a affects the advertising level on network b. The first and main source is when \( g_a \) goes up, the network a’s own advertising level goes down and then the rival’s total number of viewers increase (because it can attract more the overlapping viewers from multiple demand group) which will raise the advertising level on network b. However, when \( \alpha_b \) goes up, it will lower \( D_b \) and affect the demand of advertisement on network b in the opposite direction, which will partially offset the effect from the first source. Overall, when \( g_a \) increases, \( \alpha_b \) will also increase, and higher advertising level on network b will decrease the number of viewers on network a. Therefore, the second indirect effect will decrease the demand for advertisement, that is, it help to make the \( \alpha_a \) decrease faster as \( g_a \) increases.

The second effect is more significant in MB subgame than PB subgame. There are two reasons. First, the cross effect of the advertising level on the other network is stronger in MB subgame than PB subgame. When there is 1 unit decrease in \( \alpha_a \) it will increase \( D_b \) by \( \frac{t}{2} \) in MB subgame, while only \( \frac{t}{3} \) in PB subgame equations ((1.1) and (1.2)). The reason is: when \( \alpha_a \) decrease, in MB subgame demands for groups B and a increase such that \( p_a^{MB} \) and \( p_B^{MB} \) increase by \( \frac{t}{2} \). As the result, \( D_b^{MB} \) increases by \( \frac{t}{2} \) because of a increase of the viewers in group B. However, in PB subgame, the decrease of \( \alpha_a \) will increase \( p_B^{PB} \) by \( \frac{t}{3} \), thus the served viewers in group B will increase by frac 2 \( t \), while the served viewers in group b will decrease by \( \frac{t}{3} \), and the total viewers of network b increase by \( \frac{t}{3} \). Second, as we discussed in the previous paragraph, when \( \alpha_b \) increases as \( g_a \) increases, it will continue to lower the viewers on network b, \( D_b \), which will partially offset and weaken the demand decreasing from the first source. The offsetting effect is more significant in PB subgame, it is because the effect of advertising level on the number of viewers of the same network is stronger in PB. When \( \alpha_b \) increases by 1 unit, the \( D_b \) will decrease by more in PB. Overall, when \( \alpha_a \) increases by 1 unit, \( D_b \) will increase by more in MB subgame and thus \( \alpha_b \) will increase more in the MB subgame than PB subgame. Again, because of the stronger cross effect of the advertising level on the other network in MB subgame, the number of viewers of network a will decrease by more in MB subgame than in PB subgame.

Therefore, combining all three effects, we have:

\[
\frac{\partial \alpha_a^{MB}}{\partial g_a^{MB}} = \frac{1}{1 - \frac{\partial D_a}{\partial \alpha_a^{MB}}} \frac{\partial D_a^{MB}}{\partial \alpha_a^{MB}} = \frac{1}{(1 + \frac{t}{2})(1 + \frac{t}{2})}.
\]
We know that when advertising fee increases, the advertising level of the same network will decreases faster in MB subgame than in PB subgame.
Appendix B. Tables

Table B.1: No upstream firm, $\mu_i = 30$ (big market)

<table>
<thead>
<tr>
<th></th>
<th>Corr coef</th>
<th>$P_a$</th>
<th>$P_B$</th>
<th>$q$</th>
<th>$\pi^D$</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB</td>
<td></td>
<td>23.35</td>
<td>-</td>
<td>0.75</td>
<td>34.88</td>
</tr>
<tr>
<td>PB</td>
<td>-0.5</td>
<td>-</td>
<td>47.68</td>
<td>0.89</td>
<td>42.48</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>-</td>
<td>46.48</td>
<td>0.83</td>
<td>38.60</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>-</td>
<td>46.38</td>
<td>0.78</td>
<td>36.37</td>
</tr>
<tr>
<td>MB</td>
<td>-0.5</td>
<td>40.33</td>
<td>47.67</td>
<td>0.89</td>
<td>42.51</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>34.37</td>
<td>46.65</td>
<td>0.83</td>
<td>38.64</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>30.04</td>
<td>46.50</td>
<td>0.78</td>
<td>36.44</td>
</tr>
</tbody>
</table>
Table B.2: No upstream firm, $\mu_i = 10$ (small market)

<table>
<thead>
<tr>
<th></th>
<th>Corr coef</th>
<th>$P_a$</th>
<th>$P_B$</th>
<th>$q$</th>
<th>$\pi^D$</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB</td>
<td>-</td>
<td>11.32</td>
<td>-</td>
<td>0.45</td>
<td>10.13</td>
</tr>
<tr>
<td></td>
<td>-0.5</td>
<td>-</td>
<td>16.68</td>
<td>0.63</td>
<td>10.59</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>-</td>
<td>18.89</td>
<td>0.53</td>
<td>10.03</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>-</td>
<td>20.87</td>
<td>0.48</td>
<td>10.02</td>
</tr>
<tr>
<td></td>
<td>0.9</td>
<td>-</td>
<td>22.30</td>
<td>0.45</td>
<td>10.10</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>-</td>
<td>22.63</td>
<td>0.45</td>
<td>10.13</td>
</tr>
</tbody>
</table>

Table B.3: With advertisement, $\mu_i = 30, t\&n = 1$

<table>
<thead>
<tr>
<th></th>
<th>Corr coef</th>
<th>$P_a$</th>
<th>$P_B$</th>
<th>Ad.</th>
<th>$q$</th>
<th>$\pi^D$</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB</td>
<td>-</td>
<td>23.09</td>
<td>-</td>
<td>0.37</td>
<td>0.74</td>
<td>34.33</td>
</tr>
<tr>
<td></td>
<td>-0.5</td>
<td>-</td>
<td>46.94</td>
<td>0.44</td>
<td>0.89</td>
<td>41.66</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>-</td>
<td>45.83</td>
<td>0.41</td>
<td>0.83</td>
<td>37.91</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>-</td>
<td>45.79</td>
<td>0.39</td>
<td>0.78</td>
<td>35.76</td>
</tr>
<tr>
<td>PB</td>
<td>-0.5</td>
<td>39.68</td>
<td>47.03</td>
<td>0.44</td>
<td>0.88</td>
<td>41.69</td>
</tr>
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<td>0</td>
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<td>33.90</td>
<td>0.41</td>
<td>0.82</td>
<td>38.00</td>
</tr>
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<td>0.5</td>
<td>45.93</td>
<td>29.67</td>
<td>0.39</td>
<td>0.78</td>
<td>35.84</td>
</tr>
</tbody>
</table>
Table B.4: With advertisement, $\mu_i = 30, t\&n = 10$

<table>
<thead>
<tr>
<th>Corr coef</th>
<th>$P_a$</th>
<th>$P_B$</th>
<th>ad</th>
<th>q</th>
<th>$\pi^D$</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB</td>
<td>-</td>
<td>14.04</td>
<td>-</td>
<td>1.46</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>-0.5</td>
<td>-</td>
<td>20.33</td>
<td>1.74</td>
<td>0.68</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>-</td>
<td>21.13</td>
<td>1.76</td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>-</td>
<td>23.17</td>
<td>1.76</td>
<td>0.54</td>
</tr>
</tbody>
</table>

Table B.5: With license fee, $\mu_i = 30$

<table>
<thead>
<tr>
<th>Corr coef</th>
<th>$P_a$</th>
<th>$P_B$</th>
<th>License fee</th>
<th>q</th>
<th>$\pi^D$</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB</td>
<td>-</td>
<td>27.20</td>
<td>-</td>
<td>11.29</td>
<td>0.61</td>
</tr>
<tr>
<td></td>
<td>-0.5</td>
<td>-</td>
<td>52.36</td>
<td>13.13</td>
<td>0.78</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>-</td>
<td>52.94</td>
<td>12.59</td>
<td>0.69</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>-</td>
<td>54.09</td>
<td>12.47</td>
<td>0.63</td>
</tr>
</tbody>
</table>

Table B.6: With license fee, $\mu_i = 15$

<table>
<thead>
<tr>
<th>Corr coef</th>
<th>$P_a$</th>
<th>$P_B$</th>
<th>License fee</th>
<th>q</th>
<th>$\pi^D$</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB</td>
<td>-</td>
<td>17.27</td>
<td>-</td>
<td>6.72</td>
<td>0.41</td>
</tr>
<tr>
<td></td>
<td>-0.5</td>
<td>-</td>
<td>27.70</td>
<td>6.24</td>
<td>0.59</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>-</td>
<td>30.49</td>
<td>6.63</td>
<td>0.49</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>-</td>
<td>33.21</td>
<td>7.19</td>
<td>0.43</td>
</tr>
</tbody>
</table>
Table B.7: Comparison of elasticity under no bundling when license fee is fixed at the level of pure bundling

<table>
<thead>
<tr>
<th></th>
<th>License fee</th>
<th>p</th>
<th>q</th>
<th>dq/dp</th>
<th>( \varepsilon_q )</th>
<th>( \varepsilon_p )</th>
<th>dNP/dc</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \mu = 15 )</td>
<td>6.24</td>
<td>16.99</td>
<td>0.42</td>
<td>0.039</td>
<td>-1.58</td>
<td>0.206</td>
<td>0.04</td>
</tr>
<tr>
<td>( \mu = 30 )</td>
<td>13.13</td>
<td>27.97</td>
<td>0.58</td>
<td>0.039</td>
<td>-1.88</td>
<td>0.204</td>
<td>-0.16</td>
</tr>
</tbody>
</table>

Table B.8: With advertisement and license fee, \( \mu_i = 30, t&n = 1 \)

<table>
<thead>
<tr>
<th></th>
<th>Corr coef</th>
<th>( p_a )</th>
<th>( p_B )</th>
<th>ad</th>
<th>License fee</th>
<th>q</th>
<th>( \pi^D )</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB</td>
<td>-</td>
<td>27.00</td>
<td>-</td>
<td>0.21</td>
<td>11.10</td>
<td>0.61</td>
<td>19.38</td>
</tr>
<tr>
<td>PB</td>
<td>0.5</td>
<td>-</td>
<td>53.52</td>
<td>0.27</td>
<td>12.15</td>
<td>0.63</td>
<td>18.54</td>
</tr>
<tr>
<td>MB</td>
<td>0.5</td>
<td>31.05</td>
<td>53.47</td>
<td>0.23</td>
<td>11.53</td>
<td>0.63</td>
<td>19.58</td>
</tr>
</tbody>
</table>

\( \mu \): Parameter for the cost function, \( p \): Price, \( q \): Quantity, \( dq/dp \): Price Elasticity, \( \varepsilon_q \): Quantity Elasticity, \( \varepsilon_p \): Price Elasticity, \( dNP/dc \): Change in Net Profit/Change in Cost, \( p_a \): Price of Advertisement, \( p_B \): Price of Bundle, \( ad \): Advertisement, \( \pi^D \): Profit.
Table B.9: With advertisement and license fee, $\mu_i = 30, t & n = 5$

<table>
<thead>
<tr>
<th>Corr coef</th>
<th>$p_a$</th>
<th>$p_B$</th>
<th>ad</th>
<th>License fee</th>
<th>q</th>
<th>$\pi^D$</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB</td>
<td>-</td>
<td>22.52</td>
<td>-</td>
<td>1.00</td>
<td>7.06</td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td>-0.5</td>
<td>34.86</td>
<td>1.71</td>
<td>3.72</td>
<td>0.79</td>
<td>21.73</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>36.60</td>
<td>1.55</td>
<td>3.64</td>
<td>0.71</td>
<td>20.86</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>38.83</td>
<td>1.42</td>
<td>3.98</td>
<td>0.66</td>
<td>20.24</td>
</tr>
</tbody>
</table>

| PB        | -0.5  | 29.63 | 40.77| 1.25        | 7.40 | 0.73   | 19.99 |
|           | 0     | 27.75 | 42.57| 1.14        | 7.40 | 0.66   | 18.93 |
|           | 0.5   | 26.12 | 43.88| 1.07        | 7.28 | 0.62   | 18.53 |

Table B.10: With advertisement and license fee, $\mu_i = 30, t = 1, n = 5$

<table>
<thead>
<tr>
<th>Corr coef</th>
<th>$p_a$</th>
<th>$p_B$</th>
<th>ad</th>
<th>License fee</th>
<th>q</th>
<th>$\pi^D$</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB</td>
<td>-</td>
<td>24.82</td>
<td>-</td>
<td>1.50</td>
<td>7.56</td>
<td>0.64</td>
</tr>
<tr>
<td></td>
<td>-0.5</td>
<td>47.34</td>
<td>1.97</td>
<td>8.99</td>
<td>0.81</td>
<td>23.92</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>47.82</td>
<td>1.76</td>
<td>8.34</td>
<td>0.73</td>
<td>22.76</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>48.94</td>
<td>1.63</td>
<td>8.26</td>
<td>0.67</td>
<td>21.83</td>
</tr>
</tbody>
</table>

| MB        | -0.5  | 34.62 | 47.98| 1.87        | 8.78 | 0.78   | 24.52 |
|           | 0     | 31.74 | 48.45| 1.67        | 8.32 | 0.71   | 23.23 |
|           | 0.5   | 29.36 | 49.18| 1.57        | 8.08 | 0.67   | 22.37 |
**Table B.11:** With advertisement and license fee, $\mu_i = 30, t = 3, n = 1

<table>
<thead>
<tr>
<th></th>
<th>Corr coef</th>
<th>$p_a$</th>
<th>$p_B$</th>
<th>ad</th>
<th>License fee</th>
<th>q</th>
<th>$\pi^D$</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB</td>
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<td>27.10</td>
<td>-</td>
<td>0.04</td>
<td>11.23</td>
<td>0.61</td>
<td>19.34</td>
</tr>
<tr>
<td>PB</td>
<td>-0.5</td>
<td>-</td>
<td>50.87</td>
<td>0.24</td>
<td>12.38</td>
<td>0.78</td>
<td>20.38</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>-</td>
<td>51.82</td>
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<td>12.05</td>
<td>0.69</td>
<td>19.14</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>-</td>
<td>53.07</td>
<td>0.17</td>
<td>12.01</td>
<td>0.63</td>
<td>18.48</td>
</tr>
<tr>
<td>MB</td>
<td>-0.5</td>
<td>35.71</td>
<td>52.20</td>
<td>0.11</td>
<td>12.61</td>
<td>0.74</td>
<td>21.10</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>33.22</td>
<td>52.88</td>
<td>0.07</td>
<td>12.03</td>
<td>0.67</td>
<td>20.11</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>31.07</td>
<td>53.49</td>
<td>0.07</td>
<td>11.55</td>
<td>0.63</td>
<td>19.54</td>
</tr>
</tbody>
</table>

**Table B.12:** Welfare comparison (no upstream)

<table>
<thead>
<tr>
<th></th>
<th>Corr coef</th>
<th>$\pi^D$</th>
<th>CS</th>
<th>Total surplus</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB</td>
<td>-</td>
<td>34.88</td>
<td>16.33</td>
<td>51.21</td>
</tr>
<tr>
<td>PB</td>
<td>-0.5</td>
<td>42.48</td>
<td>12.84</td>
<td>55.32</td>
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<td>14.80</td>
<td>53.40</td>
</tr>
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<td>36.37</td>
<td>15.75</td>
<td>52.12</td>
</tr>
<tr>
<td>MB</td>
<td>-0.5</td>
<td>42.51</td>
<td>12.84</td>
<td>55.35</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>38.64</td>
<td>14.77</td>
<td>53.41</td>
</tr>
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<td>0.5</td>
<td>36.44</td>
<td>15.70</td>
<td>52.14</td>
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</table>
Table B.13: Welfare comparison (with ad), \( t\&n = 1 \)

<table>
<thead>
<tr>
<th></th>
<th>Corr coef</th>
<th>( \pi^D )</th>
<th>( \pi^U )</th>
<th>CS</th>
<th>CS\textsuperscript{ad}</th>
<th>Total surplus</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB</td>
<td>-</td>
<td>34.33</td>
<td>0.13</td>
<td>16.17</td>
<td>0.07</td>
<td>50.9</td>
</tr>
<tr>
<td></td>
<td>-0.5</td>
<td>41.66</td>
<td>0.20</td>
<td>12.71</td>
<td>0.098</td>
<td>54.97</td>
</tr>
<tr>
<td>PB</td>
<td>0</td>
<td>37.91</td>
<td>0.17</td>
<td>14.66</td>
<td>0.085</td>
<td>53.08</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>35.76</td>
<td>0.15</td>
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Table B.14: Welfare comparison (with ad), \( t\&n = 10 \)

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<th>( \pi^U )</th>
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<th>CS\textsuperscript{ad}</th>
<th>Total surplus</th>
</tr>
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<td>4.46</td>
<td>45.84</td>
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Table B.15: Welfare comparison (with ad and license fee), $t&n = 1$

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<th>CS$^{ad}$</th>
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Table B.16: Welfare comparison (with ad and license fee), $t&n = 5$

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Table B.17: Sample statistics: television programming service data

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<td>$53.9</td>
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Table B.19: Sample statistics: advertisement data

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<th>Max</th>
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<td>(.123)</td>
<td>Norfolk-Portsmt-Newpt Nws</td>
</tr>
<tr>
<td>Memphis</td>
<td>6.462***</td>
<td>(.076)</td>
<td>Oklahoma City</td>
</tr>
<tr>
<td>Location</td>
<td>Value (SE)</td>
<td>Location</td>
<td>Value (SE)</td>
</tr>
<tr>
<td>---------------------</td>
<td>------------</td>
<td>---------------------</td>
<td>------------</td>
</tr>
<tr>
<td>Albuquerque-Santa Fe</td>
<td>2.446 (0.070)</td>
<td>Greensboro-H.Point-W.Salem</td>
<td>1.858 (0.062)</td>
</tr>
<tr>
<td>Las Vegas</td>
<td>1.946 (0.064)</td>
<td>Buffalo</td>
<td>5.976 (0.069)</td>
</tr>
<tr>
<td>Louisville</td>
<td>7.903 (0.076)</td>
<td>Jacksonville</td>
<td>3.220 (0.064)</td>
</tr>
<tr>
<td>Austin</td>
<td>14.406 (0.114)</td>
<td>Albany-Schenectady-Troy</td>
<td>0.236 (0.117)</td>
</tr>
<tr>
<td>Fresno-Visalia</td>
<td>-6.615 (0.141)</td>
<td>Knoxville</td>
<td>7.945 (0.076)</td>
</tr>
<tr>
<td>Richmond-Petersburg</td>
<td>5.161 (0.065)</td>
<td>Tulsa</td>
<td>0.463 (0.068)</td>
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</table>

Note: The interactive terms of channels and days of the week are not reported.
Table B.21: Median of the maximum own advertisement elasticity of audience size

<table>
<thead>
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<th>Channel</th>
<th>Elasticity</th>
<th>Channel</th>
<th>Elasticity</th>
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<tr>
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<td>amc</td>
<td>-11.89</td>
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<tr>
<td>apl</td>
<td>-20.03</td>
<td>bet</td>
<td>-26.68</td>
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<tr>
<td>cmdy</td>
<td>-21.30</td>
<td>cnbc</td>
<td>-21.94</td>
</tr>
<tr>
<td>cnn</td>
<td>-21.02</td>
<td>disc</td>
<td>-20.23</td>
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<tr>
<td>ent</td>
<td>-25.39</td>
<td>espn</td>
<td>-18.14</td>
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<td>espn2</td>
<td>-16.50</td>
<td>food_ch</td>
<td>-24.15</td>
</tr>
<tr>
<td>fx</td>
<td>-19.97</td>
<td>fxnc</td>
<td>-21.33</td>
</tr>
<tr>
<td>hgtv</td>
<td>-22.30</td>
<td>hist</td>
<td>-20.15</td>
</tr>
<tr>
<td>lif</td>
<td>-25.91</td>
<td>msnbc</td>
<td>-22.61</td>
</tr>
<tr>
<td>mtv</td>
<td>-23.65</td>
<td>nick</td>
<td>-6.35</td>
</tr>
<tr>
<td>sci-fi</td>
<td>-22.63</td>
<td>spk</td>
<td>-25.36</td>
</tr>
<tr>
<td>tbsc</td>
<td>-21.07</td>
<td>tlc</td>
<td>-20.17</td>
</tr>
<tr>
<td>tnt</td>
<td>-19.45</td>
<td>tvl</td>
<td>-23.72</td>
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<tr>
<td>twc</td>
<td>-22.87</td>
<td>usa</td>
<td>-24.36</td>
</tr>
<tr>
<td>vh1</td>
<td>-25.51</td>
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The elasticities are calculated by using the maximum disutility from advertisement ($\alpha$).
Table B.22: Cable service subscription parameter estimates

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate (std. error)</th>
<th>Variable</th>
<th>Estimate (std. error)</th>
</tr>
</thead>
<tbody>
<tr>
<td>monthly_fee</td>
<td>-1.261*** (.263)</td>
<td>b_dum</td>
<td>.072 (5.389)</td>
</tr>
<tr>
<td>cab_dum</td>
<td>2.468 (6.847)</td>
<td>internet</td>
<td>-.746 (5.093)</td>
</tr>
<tr>
<td>xb1_dum</td>
<td>-5.170 (3.830)</td>
<td>cbridge</td>
<td>7.344* (3.903)</td>
</tr>
<tr>
<td>charter</td>
<td>30.444** (13.971)</td>
<td>adelph</td>
<td>24.128 (24.186)</td>
</tr>
<tr>
<td>comcast</td>
<td>9.946 (36.547)</td>
<td>tw</td>
<td>-5.502 (9.187)</td>
</tr>
<tr>
<td>media</td>
<td>-12.744 (13.396)</td>
<td>_cons</td>
<td>141.228*** (15.426)</td>
</tr>
</tbody>
</table>

Note: the coefficients of DMA dummies are not reported
Table B.23: Inverse demand for ads. parameter estimates

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate (std. error)</th>
<th>Variable</th>
<th>Estimate (std. error)</th>
</tr>
</thead>
<tbody>
<tr>
<td>unit</td>
<td>-.033 (.119)</td>
<td>_cons</td>
<td>2.603** (1.124)</td>
</tr>
<tr>
<td>GRP</td>
<td>.061 (.089)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>comedy_show</td>
<td>3.915** (1.828)</td>
<td>movie_drama</td>
<td>-2.045 (1.299)</td>
</tr>
<tr>
<td>csi</td>
<td>-11.307*** (2.758)</td>
<td>movie_horror</td>
<td>-1.975* (1.119)</td>
</tr>
<tr>
<td>documentary</td>
<td>-3.200* (1.867)</td>
<td>movie_thriller</td>
<td>-1.091 (1.396)</td>
</tr>
<tr>
<td>reality</td>
<td>.462 (1.052)</td>
<td>movie_western</td>
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<tr>
<td>sitcom</td>
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<td>music</td>
<td>-.177 (1.482)</td>
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<tr>
<td>drama</td>
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<td>news</td>
<td>2.710 (3.109)</td>
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<tr>
<td>kids_show</td>
<td>Dropped</td>
<td>Sports_baseball</td>
<td>-.252 (1.558)</td>
</tr>
<tr>
<td>law_order</td>
<td>-6.060*** (2.311)</td>
<td>Sports_basketball</td>
<td>1.384 (2.374)</td>
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<tr>
<td>movie_action</td>
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<td>sports_wrestling</td>
<td>-9.106** (3.613)</td>
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<tr>
<td>movie_comedy</td>
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<td>sports_other</td>
<td>4.122*** (1.596)</td>
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<tr>
<td>movie_crime</td>
<td>.547 (2.301)</td>
<td>food</td>
<td>.750 (2.936)</td>
</tr>
<tr>
<td>mon</td>
<td>1.428** (.634)</td>
<td>thr</td>
<td>.326 (.482)</td>
</tr>
<tr>
<td>tue</td>
<td>1.229** (.518)</td>
<td>fri</td>
<td>1.25** (.563)</td>
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<tr>
<td>wed</td>
<td>1.011** (.478)</td>
<td>sat</td>
<td>.215 (.721)</td>
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<tr>
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<td>amc</td>
<td>5.497*** (.895)</td>
</tr>
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<td>apl</td>
<td>7.623*** (1.427)</td>
<td>bet</td>
<td>1.091 (.733)</td>
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<td>6.215*** (1.952)</td>
<td>cnbc</td>
<td>2.637 (3.154)</td>
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<tr>
<td>cnn</td>
<td>29.538*** (3.365)</td>
<td>disc</td>
<td>29.664*** (3.076)</td>
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<td>ent</td>
<td>15.854*** (1.040)</td>
<td>espn</td>
<td>8.597*** (1.423)</td>
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<td>espn2</td>
<td>2.230* (1.315)</td>
<td>food_ch</td>
<td>4.061*** (1.366)</td>
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<td>Channel</td>
<td>Log Likelihood</td>
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<td>---------</td>
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<td>fxnc</td>
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<td></td>
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<td>msnbc</td>
<td>1.881</td>
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<td>scifi</td>
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<td>(1.087)</td>
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<td>5.735***</td>
<td>tbsc</td>
<td>5.153***</td>
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<tr>
<td></td>
<td>(.955)</td>
<td></td>
<td>(.796)</td>
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<td>tnt</td>
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<td>(2.007)</td>
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<td>twc</td>
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<td></td>
<td>(1.382)</td>
<td></td>
<td>(1.326)</td>
</tr>
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<td>usa</td>
<td>6.611***</td>
<td>vh1</td>
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<tr>
<td></td>
<td>(1.475)</td>
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<td>(.894)</td>
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### Table B.24: License fees

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<td>amc</td>
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<tr>
<td>apl</td>
<td>0.139</td>
<td>bet</td>
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<tr>
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<td>cnbc</td>
<td>0.021</td>
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<tr>
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<td>0.119</td>
<td>disc</td>
<td>0.184</td>
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<td>0.006</td>
<td>espn</td>
<td>0.892</td>
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<tr>
<td>espn2</td>
<td>0.352</td>
<td>food_ch</td>
<td>0.018</td>
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<tr>
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<td>0.176</td>
<td>fxnc</td>
<td>0.157</td>
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<td>hist</td>
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<td>0.024</td>
<td>msnbc</td>
<td>0.045</td>
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<td>0.047</td>
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<td>0.054</td>
<td>spk</td>
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<td>0.166</td>
<td>tlc</td>
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<td>tvl</td>
<td>0.022</td>
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### Table B.25: Marginal costs

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<td>5</td>
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Appendix C. Figures and Graphics

Figure C.1: Description of Model
Figure C.2: Subscription Fees in the Equilibria

Figure C.3: Number of Viewers in the Equilibria
Figure C.4: Advertising Fees in the Equilibria

Figure C.5: Advertising Levels in the Equilibria
Figure C.6: Consumer Surplus in the Equilibria

Figure C.7: Number of Viewers Comparison
Figure C.8: Ads Levels Comparison

Figure C.9: Consumer Surplus Comparison
Figure C.10: Bundle Flattens Demand

Figure C.11: Demand under No Bundling
Figure C.12: Demand under Pure Bundling

Figure C.13: Demand under Mixed Bundling
Figure C.14: Demand under NB when c is fixed at the Level of PB
Vita

EDUCATION

Ph.D. in Economics, Department of Economics, Drexel University, USA, 2010
M.A. Management, Peking University, China, 2004
B.S. Industrial Foreign Trade, Chongqing University, China, 1998

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Instructor, ECON201, Principles of Microeconomics (full responsibility)
Summer 2007-08, Winter 2008-09, Department of Economics, Drexel University
Instructor, ECON301, Intermediate Microeconomics (full responsibility)
Spring, 2009-10, Department of Economics, Drexel University

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Game Theory, Econometrics

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