Unbundling Cable Television: An Empirical Investigation*

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Abstract

I develop an empirical model of demand for large bundles, and use it to analyze bundling of channels in cable television. Concerns over cable companies' bundling practices and rapid price increases have led to an active policy debate about government-mandated unbundling, i.e., requiring cable companies to offer subscriptions to "themed tiers" or individual channels on a la carte basis. I focus on the likely short-run effects of unbundling policies for consumers, cable networks and cable operators.

I model consumers' choice of cable and satellite packages (bundles of channels) and their subsequent viewing choices for individual channels in the bundle. The main identifying assumption is that consumers' willingness to pay for a bundle of channels is driven by the utility they get from viewing those channels. This allows me to identify consumers' WTPs for individual channels, even though they are always sold in large bundles, and to predict their subscriptions and viewing choices in unbundling counterfactuals. I estimate the model using individual-level data on cable and satellite subscriptions and viewing choices for 64 main cable channels.

I use the estimates to simulate the "themed tiers" unbundling scenario, which involves breaking up the bundle into 7 mini-tiers by channel genre. I find that consumers do not gain much from unbundling. The best-case increase in consumer surplus is estimated at just 35 cents per household per month. At the same time, cable networks are likely to lose a lot of subscribers, which will significantly reduce their license-fee revenues. The loss of subscribers is likely to force the networks to sharply increase the wholesale license fees they charge per subscriber, in which case unbundling would hurt consumers.

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1. Introduction

I develop an empirical model of demand for large bundles, and use it to analyze the effects of bundling in cable television. A typical cable package is a bundle containing dozens of channels, and most consumers watch only a small fraction of the channels they are paying for. For example, in 1995, an average cable household was paying for a bundle of 41 channels, but watching only 10 of them (24%).[1] By 2005, an average cable household was paying for 96 channels, and watching just 15 of them (16%). The price of a typical cable subscription increased by 93% over the same period, far outpacing inflation (28%).[2]

Concerns over rapid price increases and cable companies' bundling practices have led to an active policy debate regarding government-mandated unbundling, i.e., requiring cable companies to break up their main retail packages, and to allow consumers to pick individual channels or small "themed tiers" on a la carte basis.[3] Supporters of unbundling policies (various consumer organizations, and, until recently, the FCC[4]) argue that it would significantly benefit consumers, by reducing their cable bills and giving them more choice. On the other hand, opponents of unbundling policies (most of the cable companies and programmers) argue that it would increase cable prices and destroy the economic foundations of the cable networks, reducing the quality and diversity of programming in the long run.[5] More than 80% of US households subscribe to cable or satellite, and an average cable household spends more than 8 hours a day watching television (Nielsen [2006]) and more than $600 a year paying for it (FCC [2005a]), so a lot is at stake in this policy debate. However, empirical evidence is scarce (in fact, the only empirical analysis of cable unbundling I am aware of is the parallel papers by Crawford and Yurukoglu [2008, 2009], discussed later).

In the empirical analysis, I address two main questions. First, what are the likely effects of unbundling policies for consumers? The answer to this question is key to the debate, since the push for unbundling is based on the argument that it will substantially benefit consumers. Second, what are the likely effects for the industry? Specifically, how will it affect prices, subscriptions, ratings and profits for cable operators and cable networks? Importantly, I focus on the short-run effects,

[1] Souce: Nielsen Research, www.nielsenmedia.com.

[2] FCC (2006).

[3] For example, in response to requests from members of Congress, the Federal Communications Commission (FCC) and the Government Accountability Office (GAO) have published three reports (FCC [2004, 2006], GAO [2003]) analyzing the effects of a switch to full a la carte or "themed tiers", and the then FCC chairman Kevin Martin argued for unbundling in numerous congressional hearings (e.g., November 2005, April 2007, April 2008). Legislation for cable unbundling was introduced in Congress on several occasions (by Senator John McCain in 2006, and by Representatives Dan Lipinski and Jeff Fortenberry in 2008), however it did not get much traction in the committees. Notice that there is also a separate (but closely-related) debate about "wholesale unbundling" in the upstream market for cable programming.

[4] The FCC actively pushed for unbundling under former Chairman Kevin Martin (2005-2009), but made it a lower priority under current FCC Chairman Julius Genachowski (since 2009).

[5] Reports by FCC (2006) and Booz, Allen, Hamilton (2004) are representative of the two sides' main arguments. Although the two reports reach very different conclusions, both acknowledge lack of any serious empirical evidence on the key issues in this debate (e.g., Booz, Allen, Hamilton [2004] page 19, FCC [2006] page 39).

i.e., I hold the set of available networks and the quality of their programming fixed. One major concern about unbundling is that it can sharply reduce cable networks' subscriber base and ratings (their two main sources of revenue), which in the long run can destroy many niche networks and force others to sharply cut their investment in programming. Thus, the short-run outcomes for the networks can have important long-run welfare effects for all market participants.

Unbundling at the retail level is likely to dramatically alter the equilibrium in the wholesale market for cable programming (see section 2.2 for details). While full analysis would require a credible empirical model of the wholesale market, which is likely to be prohibitively complex,[6] I use a simpler approach. Specifically, first I estimate a detailed model of consumers' demand for cable bundles and their viewing choices, which allows me to predict their unbundled subscriptions and viewing choices (for a given vector of retail prices) in counterfactuals. In counterfactuals, I compute cable operators' optimal choice of unbundled retail prices, treating the structure of their programming costs (the license fees they pay to the networks) as exogenously given. I explore several alternative scenarios for the programming costs, which allows me to bound the range of likely short-run effects of unbundling.

The empirical model allows me to address an additional question. Specifically, how important are the discriminatory effects of bundling in the data? The price-discrimination theory of bundling (e.g., Stigler [1963], Adams and Yellen [1976], Schmalensee [1984], McAfee et al [1989]) is one of the main explanations for the widespread use of bundling, and cable television is often cited as a natural example to illustrate this theory (e.g., Salinger [1995], Bakos and Brynjolfsson [1999]). However, empirical evidence is scarce. In fact, the only empirical study I am aware of that focuses on the discriminatory effects of bundling is Crawford (2008). He presents reduced-form evidence for cable television that offers some support for the price-discrimination theory. In addition, several empirical papers analyze other aspects of bundling. In particular, Chu, Leslie and Sorensen (2006) analyze simple alternatives to mixed bundling for season tickets, Crawford and Yurukoglu (2008, 2009) analyze the welfare effects of unbundling policies in cable television, and Ho, Ho and Mortimer (2008) analyze the effects of full-line forcing contracts in the video rental industry.

Bundling is common in many markets (for example, software suites, season tickets, triple-play bundles), and possible anticompetitive effects of bundling have drawn a lot of attention from researchers and policymakers.[7] Theoretical literature identifies several effects of bundling.

First, as mentioned above, bundling may have discriminatory effects, facilitating surplus extraction by the firm. The sign and magnitude of this effect depends on the covariance structure of preferences for the bundled goods, since the firm can extract a greater fraction of the total surplus

[6] Specifically, it would have to realistically capture bargaining between programmers such as Disney and cable operators such as Comcast, in which both sides have substantial market power and negotiate complex multi-year multi-channel deals. Crawford and Yurukoglu (2009) explicitly model the bargaining in this market, but to do that, they have to introduce a number of highly restrictive assumptions for tractability (for example, they have to ignore the multi-channel nature of actual bargaining in this market).

[7] For example, the first theoretical exposition of discriminatory effects of bundling, Stigler (1963), was inspired by antitrust cases focusing on block-booking of movies. Recent high-profile examples include the Microsoft case and the antitrust review of the proposed merger between GE and Honeywell.

if consumers' bundle valuations (the total for all the goods in the bundle) are less heterogeneous. Bakos and Brynjolfsson (1999) show that this effect is likely to be particularly strong for large bundles, such as cable packages. In general, this effect has ambiguous implications for consumer surplus, profits and total welfare. The signs and magnitudes of these welfare implications depend on the covariance structure of preferences and the marginal costs of the bundled goods.

Second, bundling may have entry-deterrence or leverage effects (e.g., Whinston [1990], Nalebuff [2000, 2004], Bakos and Brynjolfsson [2000]). There are widespread concerns about entry-deterrence and leverage effects in the upstream market for cable programming.[8] However, at the retail level (the main focus of my analysis), entry-deterrence effects do not appear to be relevant.[9] Likewise, the leverage effects of bundling are unlikely to be important at the retail level, for two reasons. First, most cable programming is available to all market participants, so there is not much exclusive programming that could be leveraged via bundling (the only exception is certain types of on-demand and local sports programming discussed in section 2.2). Second, for cable television, the leverage mechanism (which works by forcing consumers who want the exclusive good to buy the other goods from the same firm) does not require bundling. Notice that, with or without bundling, consumers are unlikely to combine subscriptions from multiple retail providers (for example, Comcast and DirecTV), because doing so would double their equipment charges and other fees. Thus, while exclusive access to programming might give a cable operator an advantage against its competitors (which my demand model allows to capture), the role of bundling in leveraging this advantage is minor.

Third, bundling may provide efficiency benefits such as economies of scale or scope, or simpler, more convenient choices for consumers (see Nalebuff [2003] for a review of such benefits). For cable companies, the main efficiency benefits of bundling are lower equipment and customer-service costs.[10] Also, as mentioned earlier, retail unbundling will significantly affect the wholesale market for cable programming. For reasons discussed in section 2.2, the wholesale prices (networks' license fees per subscriber) are likely to increase a lot after unbundling.

Unbundling can benefit consumers in several ways in the short run. If the discriminatory effects of bundling are strong, unbundling may significantly reduce cable operators' ability to extract surplus from consumers, resulting in a transfer of surplus from cable operators to consumers. Also, depending on how it affects the total costs of cable programming, it may result in a transfer of surplus from networks to consumers. Besides redistribution of surplus, unbundling may increase the total surplus, by partially serving consumers who are inefficiently excluded under bundling (e.g., current non-subscribers who value ESPN at more than its unbundled price). On the other

[8] For example, Consumers Union outlines possible anticompetitive effects in its FCC filing (Aug 13, 2004), available at hearusnow.org/cablesatellite/5/.

[9] In the past 15 years there was successful entry by DirecTV and Dish, and (so far) successful entry by Verizon FiOS and AT&T U-Verse. Thus, entry barriers created by bundling (if there are any) are not insurmountable.

[10] Unbundling would require much wider deployment of digital set-top boxes, capable of blocking flexible combinations of channels. However, cable operators are gradually switching to all-digital networks anyway (e.g., *Multichannel News*, June 26, 2008), so this factor is becoming less important. Also, unbundling is likely to increase the number and length of calls at cable operators' call centers, driving up their customer-service costs.

hand, it may reduce total surplus, by inefficiently excluding some of the current bundle buyers (e.g., those who value ESPN at above zero but below its unbundled price), and by increasing the equipment and customer-service costs. The combined effect of these factors is ambiguous, making it an empirical question.

The main challenge in the empirical analysis is to identify consumers' valuations for individual channels. In order to predict the outcomes in unbundling counterfactuals and to characterize the effects of bundling, I need to estimate consumers' willingness to pay for each channel, as well as the covariance structure of their WTPs across channels, since it is driving the discriminatory effects of bundling. However, most channels are always sold in large bundles containing dozens of channels, so I do not observe any unbundled sales for most channels (the only exception is premium channels like HBO, which are sold on a la carte basis). Thus, while consumers' bundle choices reliably identify their valuations for entire bundles, I need a way to break them down into channel valuations.

My identification strategy is based on combining data on consumers' purchases (of entire bundles) with additional data on their viewing choices (for individual channels). The fundamental assumption is that consumers subscribe to cable television because they want to watch cable television. Thus, their valuation of a bundle of channels is driven the utility they expect to get from viewing those channels. The viewing utilities for individual channels can be identified from consumers' observed viewing choices. Notice that the viewing data allows me to identify the joint distribution of consumers' valuations for individual channels despite the fact that these channels are always sold in large bundles. Next, expected viewing utility for the bundle is the result of explicit utility maximization over the channels in that bundle. This links bundle utility to channel utilities in a fully structural, internally-consistent way. Finally, by combining it with data on consumers' bundle choices and prices, I can link viewing utilities to dollars.[11]

To implement this approach, I develop a structural empirical model in which I jointly model consumers' choice of a bundle of channels and their viewing choices conditional on that bundle. Notice that consumers self-select into different bundles depending on their unobserved viewing preferences, therefore it is important to model their viewing and bundle choices *jointly*, in order to account for this self-selection.[12] The viewing part of the model is rooted in a standard random-utility discrete-choice framework, which allows me to account for substitution among channels. Since cable bundles contain dozens of channels competing for consumers' limited time, substitution among them is likely to be important. For example, the contribution of CNN to the value of a bundle likely depends on whether it also includes Fox News and MSNBC. By linking bundle utility to channel utilities via explicit utility maximization, I can fully account for such interactions.

[11] The same approach was used earlier by Ho (2006). She estimates demand for managed care plans, which offer access to a network of hospitals (among other things). She measures the contribution of each hospital to the value of the plan for consumers, using data on their hospital choices. Crawford and Yurukoglu (2008, 2009) use the same approach.

[12] For example, suppose that those with higher viewing preferences are also more likely to subscribe to cable. If this self-selection is ignored in estimation, the model would overpredict the utility of cable television for current non-subscribers. Consequently, it would overestimate the welfare gains from unbundling for current non-subscribers (notice that some of them would buy the channels they value after unbundling).

I estimate the model using individual-level data from Simmons Research, which contains consumers' viewing choices for 64 main cable channels and their subscriptions to cable and satellite, combined with several additional sources of data. Compared to more widely-available market-level data, individual-level data provides several important advantages. First, since I directly observe subscriptions and viewing choices for the same household, I can account for consumers' self-selection into different bundles driven by their unobserved viewing preferences. Second, I directly observe choices of multiple channels for the same individual, and I directly observe viewing choices by multiple individuals within the same household. This allows me to accurately identify the covariance structure of preferences (the key driver of the discriminatory effects of bundling), both across channels and across individuals within the household. Thus, the main advantage of individual-level data is that it allows one to directly observe the empirical *joint* distribution of various outcomes. In contrast, even with very detailed market-level data, one only observes the *marginal* distributions, separately for each outcome. As a result, the identification of self-selection and covariances in market-level data has to rely heavily on functional form assumptions.

A closely-related, parallel paper by Crawford and Yurukoglu (2008) focuses on the same main question and uses a similar identification strategy. The main differences between our papers are driven by the differences in the data. Specifically, I use individual-level data, while Crawford and Yurukoglu use market-level data (local ratings and market shares for a large number of markets). As discussed above, the main advantage of individual-level data it that it allows one to get much more accurate estimates of the covariance structure of channel preferences, and to properly control for self-selection, both of which are crucial for evaluating the magnitude of discriminatory effects.[13] In a follow-up paper, Crawford and Yurukoglu (2009) expand the analysis by endogenizing the wholesale prices of cable programming in the upstream market. They explicitly model the bargaining between cable networks and cable operators in the upstream market, which allows them to predict the change in upstream prices (networks' license fees per subscriber) after unbundling. The retail part of the model, and the related data limitations, are similar to those in Crawford and Yurukoglu (2008).

I use the estimates to simulate the (short-run) effects of unbundling policies. My main unbundling counterfactual is "themed tiers", in which the cable bundle is broken up into seven mini-tiers based on channel genre.[14] I compute the outcomes for retail prices, subscriptions and viewership for several alternative scenarios on how cable operators' programming costs change after unbundling. Notice that unlike Crawford and Yurukoglu (2009), I do not attempt to endogenize the upstream prices. Instead, I consider several exogenously-given scenarios for how the upstream prices will change after unbundling. The main reason is that a bargaining model that can realistically capture the key institutional details of the upstream market (long-term contracts that cover multiple channels[15]) would be prohibitively complex. Furthermore, based on my estimates, I find that there

[13] Another potentially important difference is in how we model the substitution patterns among channels. I capture them in a fully structural way, while Crawford and Yurukoglu rely on approximations.

[14] This is one of the main unbundling scenarios in FCC (2006). Another widely-discussed option is unbundling to the level of individual channels. For reasons discussed in section 7, I use the mini-tiers as my primary scenario.

[15] Notice that the multi-channel nature of these arrangements is important in practice, and leads to frequent

is simply no need to add an extra layer of assumptions required to endogenize the upstream prices, since my predictions for simpler scenarios yield sufficiently informative bounds on the welfare effects of unbundling.

I find that consumers do not gain much from unbundling. Even if the cable networks do not increase their wholesale license fees per subscriber after unbundling (the best-case scenario for consumers), the average gain in consumer surplus is estimated at just 35 cents per household per month.[16] Cable networks' license-fee revenues drop substantially in this case, because cable subscribers are no longer forced to subscribe to the networks they do not value. If the networks increase their license fees per subscriber to try to offset this loss of revenue, consumer end up being worse off than they were under bundling. Thus, my results do not support the main justification for unbundling (gains to consumers), but they do support the main concern about unbundling (significant loss of revenue for the networks).

Surprisingly, I find that there are no strong discriminatory effects of bundling. In other words, bundling does not facilitate surplus extraction from consumers by cable operators, relative to unbundled sales. The reason is that consumers' bundle valuations are quite heterogeneous, despite the size of a typical cable bundle, and this heterogeneity constrains cable operator's ability to extract surplus via bundling. The lack of discriminatory effects explains why consumers do not gain much from unbundling: cable operators can extract surplus from them with equal effectiveness through unbundled sales.

In the next section, I discuss the relevant industry background. In section 3, I present a simplified version of the model, to illustrate the logic of my approach. Sections 4-7 present the data, empirical specification, estimation and empirical results. Section 8 concludes.

2. Industry Background

I focus on the subscription television industry in years 2003-2004 (before the entry by Verizon FiOS and AT&T U-verse, before triple-play bundles, and before widespread adoption of DVRs). I discuss the retail level of the industry first, and after that the upstream interactions between cable and satellite operators and other players in the market.

2.1. Retail Level

There are three ways to receive television programming: local antenna, cable and satellite. In 2004, 16% of TV households in the US used local antenna, 65% subscribed to cable and 19% to satellite (FCC [2005a]). Local antenna reception is free, but it only provides access to the local broadcast

disputes between cable operators and programmers. For example, a well-publicised dispute between Echostar (Dish) and Viacom erupted after Viacom tried to force Echostar to carry a large number of Viacom's less popular channels as a condition for getting access to its popular channels (*Multichannel News*, March 8, 2004).

[16] The welfare effects of unbundling are heterogeneous across consumers, with the worst outcomes for larger, poorer households.

channels (ABC, CBS, NBC, FOX, etc.), and the quality of reception is often low. Unlike broadcast channels, cable channels (such as CNN or ESPN) are only available on subscription basis, on cable and satellite.

Most areas are served by one cable operator.[17] Cable operators offer several packages (tiers) of TV channels, typically *basic*, *expanded-basic* and *digital-basic* packages.[18] The general structure of cable packages is similar everywhere, but there is a lot of variation in prices and channel lineups across locations, illustrated in section 4.2.

Basic package contains the local broadcast channels, and cable operators usually add a few cable channels. Its price is usually regulated by the local franchise authorities, while other packages and services are not subject to regulation. *Expanded-basic* package contains the main cable channels (CNN, ESPN, MTV, TNT, etc.), and it is usually the largest, most expensive package. *Digital-basic* package contains additional channels. As of January 2004, the average prices were $18.08 a month for basic cable, $27.24 for expanded-basic (on top of the basic price), with 44.6 cable channels on average, and $16.05 for digital-basic (on top of the other two packages), with 31.6 extra channels on average (FCC [2005b]). All cable subscribers have to get the basic package, and 88% of them also subscribe to expanded basic, and 35% to digital basic (FCC [2005b]). In addition, consumers can subscribe to premium channels such as HBO or Cinemax. Premium channels are offered on a la carte basis, at an average price of about $10-$12 per month.[19]

The main alternative to cable is satellite, offered by DirecTV and Dish Network.[20] Satellite television is available everywhere in the US, however its availability varies within each area (and even within the same building) due to physical reasons.[21] Satellite operators offer several base packages, roughly equivalent to digital cable in terms of channel lineup, plus premium channels and several special-interest mini-tiers such as foreign-language programming or additional sports channels. Unlike cable, there is no regional variation in prices and channel lineups for satellite. Besides the subscription fees, another potentially important cost for satellite subscribers is the cost of installation and equipment (satellite dish and receiver). However, in 2003-2004 satellite operators were offering free installation and equipment in exchange for a one-year commitment (FCC [2005a]).

2.2. Industry Structure and Contracts

[17] The only exception is several "overbuild" communities with two competing cable operators, a dominant incumbent and a relatively recent entrant ("overbuilder"). However, such communities account for just 3.1% of cable subscribers in the US, and overbuilders account for less than a fifth of those 3.1% (FCC [2005b]).

[18] Entry-level "family" packages were introduced later. Some cable systems also offer digital mini-tiers of additional foreign-language channels, movie channels or sports channels.

[19] Consumers have to get basic cable (but not higher tiers) in order to be able to subscribe to premium channels. Many cable systems also offer a "multiplexed" version of the premium channels (e.g., multiplexed HBO is a mini-package containing HBO, HBO2, HBO Family and HBO Signature).

[20] The market share of other satellite providers (Voom, older large-dish systems) is negligible. Verizon FiOS and AT&T U-verse entered the market later.

[21] Satellite reception requires an unobstructed direct line of sight from the satellite to the dish antenna on the customer's house. Thus, satellite availability depends on the latitude and terrain, and within the same area, it is lower in apartment buildings and for renters (see Goolsbee and Petrin [2004] for details).

The main players in the upstream market are the cable networks and cable and satellite operators. Cable networks create their own programming or purchase it from studios, and deliver it to cable and satellite operators via a satellite uplink. Cable and satellite operators bundle the networks into retail packages and distribute them to consumers.

Cable networks have two main sources of revenue, advertising and license fees from cable and satellite operators (on average, each is about half of the total). Most of the advertising time is sold by the networks, while cable operators get about 2 minutes per hour for local advertising.

Carriage agreements between the networks and cable operators are negotiated on long-term basis (up to 10 years). The contracts specify the license fee per subscriber, and often also the tier on which the network will be carried. Major sports networks charge the highest fees, for example ESPN charges cable operators $2.28 per subscriber per month on average, and FOX Sports $1.34 per subscriber (2004 data from SNL Kagan [2007]).[22] The most expensive non-sports channels are TNT ($0.82), Disney Channel ($0.76), USA ($0.44) and CNN ($0.43), while the fees for other major channels range between $0.10-$0.34 per subscriber per month, and most "fringe" channels are under 10 cents per subscriber.

Most of the cable networks are owned by one of the large media companies,[23] and the carriage agreements are typically negotiated as a package deal for multiple networks owned by the same company. Thus, even though the license fees in the data (SNL Kagan [2007]) are quoted separately for each network, actual contracts are usually for wholesale bundles of networks. Furthermore, the wholesale bundling requirements in these contracts appear to be practically important.[24]

Unbundling at the retail level is likely to dramatically alter the wholesale market for cable programming. Several factors may lead to sharp increases in networks' license fees per subscriber. First, subscriptions for most channels will probably drop a lot after unbundling, since cable subscribers will no longer be forced to get the channels that they do not value. Second, networks might have to increase their marketing expenditures a lot, in order to attract and retain subscribers.[25] The effect of unbundling on networks' ratings and advertising revenues is ambiguous. On the one hand, it will likely eliminate most of the occasional viewers (those who value a given channel somewhat, but not enough to pay the unbundled price for it). On the other hand, some channels may gain viewers, if unbundling reduces the number of other channels consumers subscribe to, or if it attracts additional subscribers to cable. The change in the audience composition may also increase

[22] These are average license fees for each channel. The license fees vary across cable operators depending on their bargaining power and specific terms of the contracts (which are highly proprietary).

[23] For example, among the 64 cable networks in my viewing data, 43 (67%) are owned by the 5 largest media companies (Disney, NBC Universal, News Corporation, Time Warner and Viacom). The same companies own the 4 main broadcast networks (ABC, CBS, NBC, FOX).

[24] For example, there was a well-publicised dispute between Echostar (Dish Networks) and Viacom in 2004 that centered on wholesale bundling of channels by Viacom (e.g., *Multichannel News,* March 8, 2004). The American Cable Association also argues that wholesale bundling forces them to carry a lot of costly undesired programming in order to get access to the desired programming (americancable.org).

[25] For example, the marketing expenditures for premium networks (sold a la carte) are between 15-25% of sales, vs 2-6% for the expanded-basic networks sold as a bundle (Booz, Allen, Hamilton [2004]).

or reduce the advertising rates per rating point.[26] Several additional factors may help offset the increases in the license fees. Specifically, retail unbundling will change the nature of wholesale price competition among the networks, by eliminating wholesale bundling of channels by large media companies, and by forcing the networks to directly compete for subscribers (in addition to existing competition for viewers and advertisers).[27] These changes may result in a more competitive wholesale market for cable programming. While the total effect of retail unbundling on the license fees is highly uncertain, both opponents and supporters of unbundling (e.g., Booz, Allen, Hamilton [2004] and FCC [2006]) agree that the fees per subscriber are likely to go up (even though they disagree on how much they will go up). In addition to the short-run effects discussed above, unbundling is likely to have a major long-run effect on networks' entry, exit and investment in programming, with important welfare implications in the long run.[28]

The main source of revenue for cable operators is monthly subscription fees for television services ($50.63 per subscriber on average, which accounts for 67% of their total revenue). In addition, they get revenue from their share of advertising time ($4.60 per subscriber on average, 6% of total revenue) and other services, such as phone, internet, video-on-demand, installation and equipment (27% of the total; all revenue numbers are national averages for 2004 from FCC [2005a]).[29] License fees to the networks are by far the largest component of cable operators' marginal costs, totaling $15.95/month per subscriber on average (FCC [2005a]). From conversations with industry executives, they treat most other expenditures (including customer-service costs) as fixed costs.

Several large cable operators are vertically integrated with cable networks. The largest vertically-integrated firm in my sample period is Time Warner (the owner of Time Warner Cable), which fully owns CNN, Cinemax, HBO, TBS, TNT, and 24 other national cable channels.[30] Other large cable operators own quite a lot of channels, but most of them are regional or niche channels, with relatively few major national channels.[31] Vertically-integrated cable operators are required to make their channels available to competitors on reasonable terms, and exclusive contracts are

[26] For example, if advertisers value the total reach of their advertising (the number of *unique* viewers reached at least once), then the exclusion of occasional viewers can reduce the advertising rates per rating point. On the other hand, if advertisers value the ability to reach a well-defined niche audience, advertising rates can increase.

[27] Under bundling, networks compete to gain carriage on cable systems, or to be placed on a more popular tier by the cable operator, but they do not directly compete with each other for retail subscriptions.

[28] Opponents and supporters of unbundling offer widely divergent long-run projections, ranging from large declines in quality or complete destruction of many networks (Booz, Allen, Hamilton [2004]) to emergence of a more vibrant and diverse programming market (FCC [2006]).

[29] Triple-play bundles were introduced later, but by 2003-2004 cable companies were offering broadband internet in most markets, and phone services in relatively few markets.

[30] Time Warner has since separated Time Warner Cable through a spin-off, completed in March 2009 (http://ir.timewarnercable.com/separationfaq.cfm).

[31] Other large vertically-integrated operators are Cablevision, Comcast and Cox. They own some of the major regional sports networks and local news channels, but few of the major national networks. For example, among the 64 national cable channels in my viewing data, Cablevision, Comcast and Cox combined have partial ownership in 13 channels, and these are mostly "fringe" channels (they account for less than 12% of the total cost of cable programming).

generally not allowed (FCC [2005a]).[32]

3. Basic Model Specification

In this section, I present a simplified version of the empirical model, to illustrate the general logic of my approach. For clarity, I keep it as simple as possible, and defer most of the practical details to the empirical specification in section 5.

The model is a two-stage model of demand for bundles of channels and TV-viewing. In the first stage, I model household's decision to subscribe to a bundle of channels. Notice that a "bundle" refers to the combination of all packages and premium channels purchased by the household, for example "basic"+"expanded-basic"+"HBO" (in unbundling counterfactuals, each possible combination of channels or mini-tiers is treated as a separate bundle). In the second stage, I model the viewing choices for each individual within the household, conditional on the bundle they subscribe to.

The key assumption is that consumers' bundle subscriptions in stage 1 are driven by the utility they expect to get from watching the channels in the bundle in stage 2. Thus, stage 2 identifies the utility they get from viewing each channel, while stage 1 links bundle choices to viewing utilities and prices. The time frame of the model is dictated by the structure of my data (a cross-section of viewing times for each channel over the past week for each individual, with multiple individuals observed for each household).

It is more convenient to present the model backwards: first the viewing choices conditional on the bundle, then the bundle subscription choice.

3.1. Stage 2: TV-viewing Conditional on the bundle

Household h subscribes to bundle S_h, where S_h lists the channels in the bundle. Household members $i = 1...K_h$ have observed characteristics $X_{h,i}$ and unobserved (to the researcher) characteristics $w_{h,i}$. There are T periods per week.[33] In each period t, individual i can choose to watch one of the channels in the bundle ($j \in S_h$) or the outside alternative $j = 0$.

Her utility from watching channel $j \in S_h$ in period t follows a standard random-coefficients specification

$$U_{h,i,j,t} = \eta_j + Z_j \beta_{h,i} + \varepsilon_{h,i,j,t}$$

where η_j is the vertical characteristic of channel j, Z_j are its horizontal characteristics, $\beta_{h,i}$ are individual i's preferences, and $\varepsilon_{h,i,j,t}$ are i.i.d. logit (type-I extreme value) shocks. The preferences

[32] There are several exceptions. Specifically, DirecTV has exclusive rights to NFL Sunday Ticket, and cable operators have exclusive rights to regional sports networks in some markets (FCC [2005a]). These exclusive deals exploit loopholes in the regulation.

[33] For simplicity, I treat all time periods the same. With more detailed data, the model can be extended to accommodate differences across shows or day parts (e.g., daytime and primetime).

are specified as

$$\beta_{h,i} = \beta X_{h,i} + w_{h,i}$$

The unobserved component of preferences is specified as $w_{h,i} = \widetilde{w}_h + \widetilde{w}_{h,i}$, where $\widetilde{w}_h$ represents unobserved preferences common to all individuals within the household, and $\widetilde{w}_{h,i}$ represents the individual-specific part of unobserved preferences. I specify them as $\widetilde{w}_{h,i} \sim N(0, \Omega)$ and $\widetilde{w}_h \sim N(0, \rho\Omega)$, where ρ determines the correlation in unobserved preferences across household members.[34] Matrices β, Ω and scalar ρ are free parameters in estimation.

The utility for the outside alternative $j = 0$ is normalized to $U_{h,i,0,t} = 0 + \varepsilon_{h,i,0,t}$, where $\varepsilon_{h,i,0,t}$ is an i.i.d. logit shock.

Notice that my actual viewing data is cross-sectional: for each individual, I observe a 64×1 vector of time spent watching each of the 64 main cable channels over the past week. Nevertheless, I chose to model the viewing choices in terms of a discrete-choice panel model (as opposed to a hazard or duration model that would directly match the structure of my data), for the following reasons. First, the underlying viewing behavior that actually generates my weekly viewing-time data is most naturally described in terms of discrete choices over short intervals of time. Second, by formulating viewing choices in terms of a discrete-choice panel model, I am able to capture substitution among channels in a clean fully-structural way. Third, it allows me to link bundle utility to channel utilities in a transparent internally-consistent fashion.[35] Notice that I would not be able to do the same in a duration model. In estimation, I aggregate predicted viewing choices for all T periods to obtain predicted time spent watching each channel over the past week, and then I match predicted viewing times to the actual viewing times in the data (see section 6 for details).

Determinants of the discriminatory effects

Discriminatory effects of bundling are driven by the covariance structure of preferences, across channels for each individual, and across individuals within each household. In turn, these covariances are determined by the parameters β, Ω and ρ, channel characteristics Z_j and the distribution of demographics $X_{h,i}$ in the population. For example, if consumers' preferences for sports and family channels are strongly negatively correlated (via either β or Ω), then their valuations for a bundle of sports and family channels will be less heterogeneous, allowing the firm to extract surplus more effectively via bundling. This may make bundling more profitable than unbundled sales.

Notice that the covariances across different individuals within the same household are also important. For example, suppose that a typical household consists of two individuals, one of which likes sports channels but not family channels, and the other has reverse preferences. In this case, even though the valuations for sports or family channels are heterogeneous across individuals,

[34] The covariance matrices of $\widetilde{w}_h$ and $\widetilde{w}_{h,i}$ do not have to be proportional to each other. The only reason I impose this assumption is to reduce the number of parameters.

[35] In a parallel paper, Crawford and Yurukoglu (2008) use a different modeling approach, and capture consumers' viewing preferences using a Cobb-Douglas utility function defined over viewing times for different channels. However, the resulting empirical model is intractable, which forces them to rely on reduced-form approximations to proxy for substitution among channels.

they are much less heterogeneous across households. As a result, the firm can extract surplus effectively using unbundled sales, and the heterogeneity-reduction advantage of bundling becomes less important.

Since cable subscription is a household-level decision, I could simplify the model and estimation by directly modeling household-level viewing preferences, after aggregating the viewing data from individual to household level. However, by explicitly modeling the viewing choices for each individual within the household, I can capture the covariance structure of channel valuations (for entire households) much more accurately. For example, suppose that the main determinants of viewing preferences (at the individual level) are gender and age. Then, the covariance structure of household-level channel valuations is likely to be quite different for different household types (e.g., a married couple of similar ages vs a married couple of dissimilar ages vs a single individual). By modeling viewing choices at the individual level, I can accurately capture the covariance patterns for different household types in a simple and transparent fashion. On the other hand, if one were to model viewing choices directly at the household level, it would require a much less transparent reduced-form specification, to account for every possible combination of household members.

Expected viewing utility for bundle S_h

In each period, after observing the shocks $\varepsilon_{h,i,j,t}$, the individual chooses the alternative that maximizes her utility among the channels in the bundle ($j \in S_h$) and the outside alternative ($j = 0$). Thus, her realized ex-post viewing utility in period t is equal to

$$\max\{U_{h,i,j,t}\}_{j\in\{S_h,0\}}$$

Before the draws of the shocks $\varepsilon_{h,i,j,t}$ for period t have been realized, her expected viewing utility for period t is

$$EU(S_h|X_{h,i}, w_{h,i}) \equiv E\left(\max\{U_{h,i,j,t}\}_{j\in\{S_h,0\}}\right)$$

where the expectation is over the draws of the $\varepsilon_{h,i,j,t}$-s. This implicitly assumes that consumers have perfect information about channel characteristics η_j, Z_j for all the channels in the bundle.[36] Notice that the unobserved preferences $w_{h,i}$ are systematic and known to the consumer, so they are not absorbed in this expectation, and the only source of uncertainty is with respect to the future draws of the shocks $\varepsilon_{h,i,j,t}$.[37]

[36] This assumption is standard in discrete-choice models of demand, i.e., most empirical papers assume that consumers have perfect information about the main characteristics of all the alternatives in the choice set, even if it contains hundreds of products (e.g., cars in Berry, Levinsohn and Pakes [1995]).

[37] I assume that all the unobservables in channel utilities are either systematic ($w_{h,i}$) or completely idiosyncratic ($\varepsilon_{h,i,j,t}$). With more detailed data, the model can be extended to accommodate a more flexible covariance structure of the shocks, e.g., I could allow for somewhat-persistent shocks in viewing preferences (such shocks would be absorbed in the expectation).

For logit shocks, this expected utility has a simple analytical expression (Ben-Akiva [1973])

$$\begin{aligned} EU(S_h|X_{h,i}, w_{h,i}) &= E\left(\max\{\eta_j + Z_j\beta_{h,i} + \varepsilon_{h,i,j,t}\}_{j\in\{S_h,0\}}\right) = \\ &= \ln\left(\sum_{j\in\{S_h,0\}} \exp\left(\eta_j + Z_j\beta_{h,i}\right)\right) \end{aligned} \tag{3.1}$$

Notice that the expected viewing utility for the bundle is not additive with respect to channel utilities. This is a natural implication of the random-utility discrete-choice framework. The reason is that different channels are substitutes for each other at any given moment. Thus, when a new channel j is added to the bundle, its contribution to bundle utility depends on which other channels are also included in the bundle, reflecting the effect of substitution among channels.

Given the estimates of channel utilities, I can compute expected viewing utility for any bundle of channels (and not just for the bundles I observe in the data). Notice that this expected viewing utility is well-defined for any combination of available channels, since it is simply $E(max)$ for several random variables with a known joint distribution. This feature is crucial for the unbundling counterfactuals, in which I have to evaluate utility for new bundles never observed in the original data.[38]

3.2. Stage 1: Bundle Subscription Choice

Household h chooses a bundle from the menu of all available bundles, which includes local antenna and various combinations of packages and premium channels on cable and satellite.[39] The subscription-stage utility from bundle S at price P is specified as

$$U(S, P|X_h, w_h) = F(EU_1, ..., EU_{K_h}) + \alpha(X_h, w_h^P)P \tag{3.2}$$

where $EU_i \equiv EU(S|X_{h,i}, w_{h,i})$ is the expected viewing utility from bundle S for household member i, $F(...)$ is a function that aggregates household members' viewing utilities,[40] $X_h \equiv (X_{h,1}, ..., X_{h,K_h})$ and $w_h \equiv (w_{h,1}, ..., w_{h,K_h})$ are the observed and unobserved characteristics for all household members $i = 1...K_h$, and $\alpha(X_h, w_h^P)$ is the price coefficient that varies across households depending on their observables X_h (e.g., income) and unobservable w_h^P.

Given the menu of all available bundles, the household chooses the bundle that yields the highest utility. After integrating out the unobservables, this yields predicted probabilities for all cable and satellite bundles. Notice that given the estimates of channel utilities, I can compute

[38] Notice that the "new products" introduced in counterfactuals are new combinations of existing channels, not new channels.

[39] For example, if the cable operator offers a basic package, an expanded-basic package and HBO, the list of possible cable bundles is: (1) basic, (2) basic + HBO, (3) basic + expanded-basic, (4) basic + expanded-basic + HBO.

[40] Average, sum, weighted average, etc – whichever fits the data the best. Notice that since EU_i is the same for all periods t (due to data limitations), I do not have to explicitly aggregate utility across periods.

expected viewing utility, and therefore predicted choice probabilities, for any new bundle (any combination of available channels). This allows me to predict bundle choices in out-of-sample unbundling counterfactuals.

The model does not include any bundle-specific idiosyncratic shocks, such as i.i.d. logit shocks for each bundle and household. This follows the pure characteristics model of Berry and Pakes (2007). This feature of the model is important for unbundling counterfactuals, since they involve introduction of a large number of new bundles in consumers' choice set. For example, if there are 50 channels, under full a la carte consumers would be choosing among 2^{50} cable bundles (all possible combinations of channels). So, if the model contained an i.i.d. logit shock for each bundle, the distribution of the maximum of bundle utilities would be unreasonably high, since at least some of the 2^{50} i.i.d. logit shocks would be extremely high. This would distort the welfare effects and the predicted market shares in counterfactuals. Berry and Pakes (2007) show that the pure characteristics model has more reasonable implications in counterfactuals that involve introducing a large number of new alternatives in the choice set.

Restrictive Assumptions and Possible Extensions

The main restrictive assumption in the model is that it treats all time periods as identical, i.e., the systematic part of channel utilities is assumed to be the same for all t-s. I impose this assumption because my data is not detailed enough to estimate a more flexible specification. However, it can be done with more detailed viewing data, for example viewing by day part for each channel. In this case, I could estimate the viewing utilities separately for daytime and primetime for each channel, and allow the effect of viewing utility on bundle choices to vary by day part (for example, a higher weight on viewing utility during primetime).

Another potentially important factor is that viewers may value an hour of TV-viewing differently depending on the type of programming. For example, consumers might value an hour of ESPN or HBO more than an hour of the Weather Channel, even if they spend the same amount of time watching both channels. This could definitely be a major concern about my empirical approach. However, when I compute predicted unbundled subscriptions for HBO and ESPN as a sanity check, they turn out to be consistent with the available evidence (see section 7 for details), mitigating this concern.

3.3. Identification

As mentioned above, I observe multiple individuals within each household. For each individual, I observe demographics $X_{h,i}$ and the vector of time spent watching each of the 64 main channels over the past week. For each household, I also observe its subscriptions to cable or satellite. I also observe the characteristics of cable packages offered in each location.

The viewing utility parameters (η_j-s, β, Ω, ρ) are identified primarily by the viewing choices in the data. Individual-level data allows me to get reliable estimates of the parameters in channel preferences, because I directly observe choices of multiple channels for each individual and household, and demographics for the same individual or household. Thus, the covariances between viewing choices and demographics (which pin down β) and the covariances in viewing choices conditional on demographics (which pin down Ω and ρ) are identified directly from the data.

The identification of η_j, β, Ω and ρ from the viewing choices is generally straightforward, the only complication is that households self-select into different bundle subscriptions depending on their unobserved viewing preferences ω_h. Thus, the distribution of ω_h conditional on the chosen bundle differs between non-subscribers and subscribers, and it also differs across different levels of subscriptions on cable and satellite. Nevertheless, for cable and satellite subscribers, the distribution of ω_h can be identified directly from the viewing data for the channels they subscribe to.

However, for non-subscribers (local-antenna households, who do not receive any cable channels), the distribution of ω_h is not directly identified from the viewing data.[41] Besides identification through functional form, part of the distribution of ω_h for them is identified through variation in characteristics of cable packages (prices and channel lineups) across locations. Notice that the characteristics of cable packages have no effect on consumers' viewing preferences, but they affect the range of unobserved viewing preferences ω_h for consumers who self-select into each subscription, and therefore they affect the distribution of observed viewing choices among subscribers. For example, suppose that the cable packages offered in location A are more attractive (lower prices or better channel lineups) than the packages offered in location B. In this case, some of the households who would have chosen local antenna in location B would subscribe to cable in location A. Thus, the distributions of ω_h among cable subscribers would be different between locations A and B, and this difference can be identified by comparing the distribution of observed viewing choices (among cable subscribers) between the two locations. As a result, I can trace out part of the distribution of ω_h for non-subscribers.

Notice that I am able to identify the covariance structure of unobserved heterogeneity even though I only have cross-sectional viewing times data and not a panel. The reason is that my cross-sectional dependent variables (viewing times) are continuous variables that capture the outcomes of multiple discrete choices, as opposed to a cross-section of mutually-exclusive binary variables (a more typical case for cross-sectional discrete-choice data). Since my dependent variables summarize the outcomes of multiple discrete choices, their covariance structure contains useful information regarding the covariances of the underlying discrete choices, which in turn identifies the covariance matrix of the unobserved heterogeneity in preferences. In contrast, a typical cross-section (of mutually-exclusive binary variables) contains the outcome of only a single discrete choice, and therefore it contains absolutely no information about the covariance matrix of unobserved heterogeneity.

A secondary source of identification for the viewing utility parameters is through variation in channel lineups across locations and across tiers, and its effect on bundle choices. For example, if basic-only subscriptions are higher in areas where ESPN is carried on basic tier (as opposed to

[41] I do not have viewing data for broadcast channels (available over the air for free), so I cannot identify the distribution of ω_h for local-antenna households from their viewing choices for broadcast television.

expanded-basic), the model will attribute it to the viewing utility for ESPN.

The parameters in $F(EU_1, ..., EU_{K_h})$, i.e., the effect of expected viewing utility on bundle choices, is identified from several sources. One source is variation in demographics across households, which affects both their viewing choices and their bundle choices. The co-movement between bundle choices and viewing choices, driven by variation in demographics, will identify the effect of viewing utility on bundle choices.

Another important source of identification for the parameters in $F(EU_1, ..., EU_{K_h})$ is variation in cable packages across locations, illustrated in section 4.2. The effect of channel lineups on subscription choices, combined with the estimates of channel utilities from the viewing data, will identify the parameters of $F(EU_1, ..., EU_{K_h})$. One issue with this source of identification is that much of the variation in channel lineups is with respect to the niche channels that relatively few people watch. However, among those who do watch a given niche channel, the viewing time patterns are comparable to those for the major channels.[42] Thus, even though each niche channel has a relatively small total audience, its impact on subscriptions among this audience is comparable to the impact of the major channels. Furthermore, different people like different niche channels, so the combined variation in the availability of niche channels is affecting a large proportion of consumers. Also, the data has meaningful variation even for the most popular channels such as CNN or ESPN. Although CNN and ESPN are available everywhere, different cable systems place them on different tiers. For example, about 10% of systems carry ESPN on the basic tier, and 90% on expanded-basic. If consumers value ESPN, the locations that offer ESPN on basic tier will have a higher share of basic-only cable subscribers, at the expense of other cable and satellite packages and local antenna. Furthermore, some of the major channels exhibit much more variation than ESPN (e.g., Discovery, Fox Sports and TBS – see section 4.2).

There is enough price variation across locations to identify the price sensitivity parameters. Notice that despite the use of individual-level data, price endogeneity is still a concern, as discussed in Berry, Levinsohn and Pakes (2004). Although the channel lineup of a cable package (which I control for) fully summarizes the main characteristics of that package, important unobserved determinants of demand may include the quality of customer service and marketing effort. Both likely vary across cable systems, and both are likely correlated with price. This gives rise to price endogeneity, which can be dealt with using standard methods.[43]

[42] For example, in the data, just 4% of consumers watched the Independent Film Channel (IFC) in the past week, vs 28% for Discovery. However, an average IFC viewer spent 2.7 hours watching IFC, while an average Discovery viewer spend 2.6 hours watching Discovery.

[43] Another related concern is possible endogeneity of channel lineups. For example, cable operators may offer a more attractive channel lineup in markets with higher (or lower) marketing effort. Most empirical literature in IO assumes that all product characteristics except price are exogenous, and the justification is that they are much harder to change than price. Notice that the same is true for channel lineups. Even though channel lineups are easy to change from the technical standpoint, cable operators are locked in multi-year contacts which usually stipulate a specific tier for each network. This constrains their ability to change the channel lineups.

4. Data

I use data from several sources. *Simmons National Consumer Survey* (May 2003 – May 2004) provides individual-level data on cable and satellite subscriptions and viewing choices for the 64 main cable channels. *The Television and Cable Factbook* (2005) provides characteristics of cable packages for each location. The license fees data is from SNL Kagan's *Cable Program Investor*.

In the empirical analysis, I focus on 4 metropolitan areas: Boston, Los Angeles, New York and San Francisco.[44] All the descriptive statistics in this section refer to these 4 areas.

4.1. Individual-Level Cable Viewing Data (*Simmons National Consumer Survey*)

The *Simmons National Consumer Survey* data is based on a self-administered paper survey conducted between May 2003 - May 2004. For each household, it samples all household members above age 18.

For each household in the sample, I observe household demographics and some information on their location and their cable and satellite subscriptions. The subscriptions data consists of binary variables for: (1) analog cable, (2) digital cable, (3) satellite, and (4) premium channels (six binary variables for subscriptions to HBO, Cinemax, Encore, The Movie Channel, Showtime and StarZ).

For household location, I observe state and DMA code.[45] Notice that each state and DMA contain multiple cable systems, with substantial variation in cable packages and prices across systems. Thus, the location variables in the data are not detailed enough to identify the exact menu of packages and prices facing each household. In the empirical analysis, I solve this problem by integrating out household's unobserved location within the DMA (section 5.3).

For each individual, I observe demographics and cable viewing data. The viewing data records how much time the individual spent watching each of the 64 main cable channels over the past 7 days (a 64×1 vector of viewing times for each individual).[46] This data covers most of the cable channels typically carried on basic and expanded-basic tiers (the main exception is *regional* sports networks like NESN or YES, which are available locally in some markets but not nationally), and many of the digital tier channels. The viewing data is self-reported by the respondent at the end of the week. This reduces the accuracy of the data. On the other hand, a useful advantage of self-reported data (compared to automatically-recorded Nielsen data) is that the respondent is

[44] I drop the rest of the data due to very time-consuming data entry (the Factbook data I have is on paper, and each large metropolitan area contains dozens of cable systems, with a lot of data for each system). Notice that cable operators set the prices of their packages locally, so I do not need a nationwide sample to be able to do meaningful counterfactuals.

[45] A DMA (Designated Market Area) is a broadcast TV market as defined by Nielsen Research. For the largest DMAs, the DMA boundaries are roughly similar to the corresponding metropolitan area (for example, Boston DMA covers most of Eastern Massachusetts and parts of Vermont and New Hampshire). I observe DMA codes only for the 14 largest DMAs.

[46] This does not include viewing data for broadcast networks (ABC, CBS, NBC, FOX, etc). The dataset contains some data for broadcast networks, but the variable definitions are quite different, and cannot be easily combined with the cable viewing data in estimation.

likely to remember and report the occasions when she was actually watching TV (i.e., paying some attention), as opposed to TV just being on (which would count as viewing in Nielsen data).

One important issue is missing data. First, even though Simmons attempts to sample all household members above age 18, many households (about 33%) have missing household members in the data. In addition, about 5% of respondents did not fill out the cable viewing part of the questionnaire at all, or reported unreasonable numbers (such as watching TV more than 24 hours a day). In the empirical analysis, I drop households with missing household members, since cable subscription is a household-level decision.[47] In addition, if a respondent did not fill out the TV-viewing part of the questionnaire or reported unreasonable total viewing time (defined as above 70 hours a week), I treat her viewing choices as unobserved in the TV-viewing part of the model, but keep the household in the bundle-choice part of the model. If these data problems are independent of consumers' unobserved viewing preferences, this sample selection does not bias the estimates. Also, I drop households that do not own a TV (about 2% of the original sample). The final sample in the empirical analysis is 2314 households, containing 4846 individuals above age 18, 95% of them with valid viewing data.

Table 1 summarizes subscription choices in the data. Compared to the national data from FCC (2005a), the proportion of local-antenna households in the 4 DMAs is somewhat higher (23% vs 16%), and the proportion of cable subscribers is somewhat lower (57% vs 65%). This is reasonable, since the quality of the outside alternative (not watching TV) is likely to be higher in the 4 large metropolitan areas I focus on.

Table 2 summarizes viewing choices for each channel, among cable and satellite subscribers. Notice that the differences in viewership across channels reflect not only differences in channel utilities, but also differences in channel availability and tier placement (both are accounted for in the empirical model). The most popular channels are CNN, Discovery, HBO, TBS and TNT, with a weekly audience of 24-28% of all cable and satellite subscribers. Interestingly, even though there are dramatic differences in audience size across channels, from 0.7% for Fuse to 28% for Discovery, the average viewing time (conditional on watching a given channel) is comparable, e.g., 2.3 hours a week for Fuse vs 2.6 hours for Discovery. Thus, even though niche channels appeal to much fewer consumers than major channels, the intensity of preferences (among their target audience) is comparable.

Table 3 presents the correlations in viewing times across channels, for several major representative channels. The correlation patterns are quite intuitive, for example the highest correlations (for the column channel in the table) are between Cartoon Network and Nickelodeon; CNN and CNN Headlines/Fox News; Discovery and History Channel; ESPN and ESPN2/FOX Sports; MTV and VH1. When I compute correlations between each pair of channels in the data, most of them are close to zero (93% are below 0.2, and two thirds are below 0.1), suggesting large potential for discriminatory effects of bundling.

[47] Also, I do not have viewing data and detailed demographics for children within the household. I tried adding reduced-form control for children in household's bundle choices, but it was insignificant in all cases.

There is a lot of cable viewing by non-subscribers. For example, 39% of local-antenna respondents (who do not receive any cable channels at home) report watching some cable channels over the past week, and on average they watched about 11 hours of cable last week (among those who report non-zero time). Furthermore, they watch a wide variety of channels.[48] In the empirical model, I explicitly account for cable viewing by non-subscribers.

4.2. Characteristics of Cable Packages (*The Television and Cable Factbook*)

The Television and Cable Factbook is the standard source of data for the cable industry. It provides detailed characteristics of cable packages for each cable system[49] in the US. For each system I observe: (1) locations served by the system, (2) channel lineups and prices for each package, and (3) prices for the premium channels. I use the 2005 edition of the Factbook, which contains data for 2004.

The Factbook data suffers from two main problems. One is missing data for prices.[50] Another is non-updating of data. For example, when I compare the 2004 and 2005 editions of the Factbook, the data for most of Adelphia, Cablevision and Charter systems is identical for both years, which suggests that the data for them was not updated in the 2005 edition. So, the data for them is for 2003 or earlier, however it does not appear to be heavily out-of-date (their channel lineups and prices are quite similar to those for systems with up-to-date data). On the other hand, the data for all of Comcast, Cox and Time Warner systems (a majority of all cable systems in my sample) was updated in the 2005 edition, i.e., the data for them is up-to-date for 2004. Despite these issues, the *Television and Cable Factbook* is the standard source of data on the cable industry, both for industry practitioners and for academic research (e.g., Goolsbee and Petrin [2004], Crawford [2008], Chipty [2001], Crawford and Yurukoglu [2008, 2009]).

In the empirical analysis, I focus on cable systems in four metropolitan areas (DMAs): Boston, Los Angeles, New York and San Francisco. I drop "overbuild" systems and systems with less than 2000 subscribers.[51] My final sample consists of 140 cable systems, which serve about 8 million cable subscribers (12% of US total). The cable systems range in size from a few thousand to 1.4 million subscribers (Time Warner Cable in Manhattan), with a median system serving around 30,000 subscribers.

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[48] A recent study by Arbitron also finds that 35% of respondents watch TV outside their home each week (mostly at a friend's house, bars and restaurants, or at work), and their viewership is spread over various genres (*Media Life Magazine*, Apr 9, 2007).

[49] A "cable system" is defined as a community or several communities that are offered the same services at the same prices from the same cable company. Large cable operators often have dozens of different cable systems within the same metropolitan area, with different prices and channel lineups.

[50] Prices are missing for 7% of basic packages, 11% of expanded-basic packages, and 25% of digital packages in my sample. In the empirical analysis, I fill in the missing prices using a regression of package prices on package characteristics, separately for each tier.

[51] "Overbuilders" (recent cable entrants competing with the incumbent) are present in a very small number of locations (e.g., some parts of Manhattan). I drop them because I do not observe specific neighborhoods in which they are active, and their market share is negligible. I drop the systems with less than 2000 subscribers because their share of all subscribers is negligible, while the data entry time is the same as for other (much larger) systems.

There is a lot of variation in prices and channel lineups across cable systems. Figure 1 illustrates variation in prices and number of channels for the most popular combination of packages, basic and expanded-basic packages *combined*. The price ranges from \$11.50 to \$63.80, and the number of cable channels ranges from 13 to 71 (this does not include broadcast channels). Some of this variation is variation across different cable operators and across different metropolitan areas, however there is also substantial variation across cable systems even when I focus on the same cable company within the same metropolitan area. Possible reasons for such variation are discussed later in this section.

Variation in Channel Availability

An important source of identification is variation across cable systems with respect to channel availability and tier placement. Table 2 presents availability and tier placement numbers for each channel (all the numbers are weighted averages across cable systems, weighted by system size). Availability of most niche channels varies across cable systems. However, major cable channels are available essentially everywhere. For them, the main source of variation is with respect to their placement on a specific tier (basic, expanded-basic or digital-basic). For some of the major channels, there is a lot of variation with respect to their placement on digital vs analog tiers. For example, the break-down between digital and analog tiers is 15% vs 81% for the Sci-Fi channel, 8% vs 87% for FOX Sports, and 11% vs 83% for the Disney Channel.[52]

However, the most popular channels (e.g., CNN, ESPN, USA) are never placed on the digital tier. For them, the variation is with respect to their placement on basic vs expanded-basic tier. For example, the break-down between basic and expanded-basic tiers is 10% vs 90% for ESPN, 5% vs 95% for CNN, and 7% vs 93% for USA.[53] Thus, there is some meaningful variation even for the most popular channels. Furthermore, the 5-10% of systems that carry CNN or other major channels on the basic tier do not appear unusual in terms of average demographics. Also, there is much more variation for some of the major channels, for example, the break-down between basic and expanded-basic tiers for TBS is 45% vs 53%, and for Discovery it is 24% vs 73%.

What is driving the variation in cable packages?

Several factors can explain the variation across cable systems. First, the price of basic cable is usually regulated by the local authorities, which may affect the optimal allocation of cable channels between basic cable and other packages, and the optimal prices of other packages. Second, some cable channels are vertically integrated with cable operators, which affects their choice of which channels to carry. Chipty (2001) finds that vertically-integrated cable operators are more likely to carry the channels they own, and less likely to carry competitors' channels. Also, the terms of carriage agreements with the cable channels (including wholesale bundling and tier placement requirements) vary across cable operators, depending on their bargaining power and when they last

[52] The numbers add up to less than 100% because not all systems carry these channels.

[53] This break-down refers only to the systems that offer separate basic and expanded-basic packages (a small percentage of systems merge them into a single "basic" package).

renegotiated the contract.[54] Third, even for the same cable operator in the same metropolitan area, different locations have different age and quality of cable infrastructure, which affects the optimal configuration of cable packages.[55] Finally, the distribution of demographics differs across locations, so it is optimal for cable operators to offer different channel lineups and prices in different locations.

5. Empirical Specification

The empirical specification follows the general structure of the basic model (section 3), with some modifications and additional details to accurately capture the practical details of cable subscriptions and viewership.

For each individual $i = 1...K_h$ within household h, I observe demographics $X_{h,i}$ and a vector of viewing times $(T_{h,i,1}, ..., T_{h,i,64})$ for the 64 main cable channels, where $T_{h,i,j}$ denotes the total time spent watching channel j in the past 7 days. For each household, I also observe its cable or satellite subscription. For each location, I observe the characteristics of all available cable packages (the characteristics of satellite packages are the same everywhere in the US).

The model is presented backwards. First, I present the TV-viewing part of the model (stage 2), conditional on household's subscription to a specific bundle of channels. Then, I present the bundle choice part of the model (stage 1).

5.1. TV-viewing Conditional on the Bundle of Channels (Stage 2)

I model the viewing choices for each individual $i = 1...K_h$ within household h. The household subscribes to a bundle S_h, where S_h lists the cable channels in the bundle. Notice that S_h only refers to cable channels, i.e., it does not include broadcast networks.[56] For non-subscribers (local-antenna households), $S_h = \varnothing$.

There are 7 days, 20 half-hour periods each day. In each period t, individual i chooses one of the cable channels j or the outside alternative ($j = 0$). The outside alternative includes not watching TV or watching one of the broadcast networks.

Channel utilities. Individual i within household h has observed demographics $X_{h,i}$ and unobserved preferences $w_{h,i}$. In each period t, her utility from watching channel $j \in S_h$ is

$$U_{h,i,j,t} = f_j(\eta_j + Z_j \beta_{h,i} + \upsilon_{h,i,j}) + \varepsilon_{h,i,j,t} \tag{5.1}$$

[54] Also, it appears that the carriage agreements for the broadcast networks are often negotiated with their local affiliates, separately for each broadcast market, and the terms of these agreements (including the wholesale bundling requirements for the cable channels affiliated with the broadcast network) vary across markets.

[55] For example, the capacity of Comcast's system in Boston, MA, is 104 standard 6MHz channels, vs 77 channels in nearby Cambridge, MA. Besides historical factors and cable companies' gradual infrastructure upgrade schedules, the age and quality of physical infrastructure may be influenced by the local authorities. For example, in franchise renewal negotiations with Comcast in 2002, Boston mayor imposed specific deadlines and conditions on its infrastructure investment in the city (http://www.cityofboston.gov/cable/franchise.asp).

[56] Although there might be some variation in the availability of "fringe" broadcast networks, the major broadcast networks (ABC, CBS, NBC, FOX) are available everywhere, and cable operators are required to carry all of them on the basic tier.

where η_j is the vertical characteristic of channel j, $\varepsilon_{h,i,j,t}$ is an i.i.d. logit (type-I extreme value) shock, and the rest of the terms are discussed below.

The term $Z_j\beta_{h,i}$ captures the utility from observed (to the researcher) horizontal channel characteristics Z_j. The preferences for Z_j are $\beta_{h,i} = \beta X_{h,i} + w^{\beta}_{h,i}$, where $X_{h,i}$ are individual i's observed demographics, and $w^{\beta}_{h,i}$ are her unobserved preferences. To account for possible within-household correlations, I specify $w^{\beta}_{h,i}$ as $w^{\beta}_{h,i} = \widetilde{w}^{\beta}_{h} + \widetilde{w}^{\beta}_{h,i}$, where $\widetilde{w}^{\beta}_{h,i} \sim N(0,\Omega)$, $\widetilde{w}^{\beta}_{h} \sim N(0,\rho\Omega)$.[57] Matrices β, Ω and scalar ρ are free parameters in estimation. Channel characteristics Z_j include channel genre and target demographics.[58]

The next term, $\upsilon_{h,i,j}$, represents channel random effects, with a flexible covariance structure across channels. It captures unobserved channel preferences, beyond the patterns captured by unobserved preferences for the horizontal characteristics Z_j. In principle, one could estimate a flexible 64×64 covariance matrix of $\upsilon_{h,i,j}$ for the 64 channels in the data, however that would require estimating an unreasonably large number of parameters. To reduce the number of parameters, I use a factor-analytic specification

$$\upsilon_{h,i,j} = \Pi_j w^{\Pi}_{h,i}$$

where Π_j is a length-M vector of free parameters for channel j, and $w^{\Pi}_{h,i}$ are the M common factors. I specify $w^{\Pi}_{h,i}$ as $w^{\Pi}_{h,i} = \widetilde{w}^{\Pi}_{h} + \widetilde{w}^{\Pi}_{h,i}$, where $\widetilde{w}^{\Pi}_{h,i} \sim N(0, I_M)$, $\widetilde{w}^{\Pi}_{h} \sim N(0,\rho I_M)$, and ρ reflects correlations across household members. The Π_j-s capture the covariance structure of unobserved channel preferences $\upsilon_{h,i,j}$. For example, two channels with similar Π_j-s will have strongly positively-correlated $\upsilon_{h,i,j}$-s, while two channels whose Π_j-s are orthogonal to each other will have uncorrelated $\upsilon_{h,i,j}$-s. Factor-analytic specifications are common in marketing (e.g., Elrod and Keane [1995]), but less common in economics (some exceptions are Sargent and Sims [1977] and Stock and Watson [1999, 2002]). While the main objective in these papers is to identify a small number of *meaningful* common factors, my objective is more modest: to find a parsimonious reduced-form specification that approximates the covariances across channels reasonably well. In estimation, I choose the number of factors M high enough to capture the covariances in the data reasonably well, but low enough to keep the number of parameters manageable.[59]

The non-linear transformation $f_j(\eta_j + Z_j\beta_{h,i} + \upsilon_{h,i,j})$ allows me to fit the main patterns in the data much better than a more standard linear specification. Specifically, when I estimated various

[57] The only reason I restrict the covariance matrices of $\widetilde{w}^{\beta}_{h,i}$ and $\widetilde{w}^{\beta}_{h}$ to be proportional to each other is to reduce the number of parameters in estimation (the data allows to identify more flexible specifications).

[58] I classify all channels into 7 mutually-exclusive genres (see table 2 for details). I compute "target demographics" for each channel as the average demographics of its national audience (% males, age, % blacks, % college grads and % households with children). To reduce the number of parameters in estimation, $Z_j\beta_{h,i}$ for each of the "target demographics" variables in Z_j only includes interaction with the corresponding respondent demographic (age enters as a squared difference). Also, I control for the difference between DMA rating and national rating for each channel, to proxy for regional differences in preferences.

[59] One way to think about the identification of M and Π_j-s is as follows. First, estimate the model with a flexible 64×64 covariance matrix Σ for $\upsilon_{h,i,j}$-s. After that, try to approximate Σ with a much smaller number of parameters Π, increasing the number of dimensions (i.e., the number of free parameters in Π) until the fit is good enough. To reduce the number of parameters, I estimate Π_j only for the 32 most popular channels, which account for about 75% of total viewership, and set it to zero for the rest of the channels.

linear specifications (with normally-distributed unobserved preferences), the model successfully captured the mean time spent watching each channel, but heavily overpredicted the proportion of non-zero viewing times (i.e., in the data, say 10% watch channel j for 3 hours, while the model would predict 30% watching it for 1 hour). In other words, the model would overpredict the proportion of consumers with *moderately low* preferences for channel j (occasional viewers), at the expense of very low and high preferences. The reason is that normal distribution has the highest density at moderate preferences. In contrast, the patterns in the data are consistent with a certain fraction of consumers having high preferences for channel j (heavy viewers), a large majority having very low preferences (non-viewers), and relatively few consumers having moderately low preferences (occasional viewers). One natural solution could be to use a different distribution for unobserved preferences (e.g., lognormal or exponential). However, I have to model covariances across 64 channels, across different product characteristics and across different household members, and that would be more difficult to do with a different distribution (for example, while the sum of two normal distributions is also normal, and its covariance structure is easy to characterize, this is not the case for the sum of two lognormal or exponential distributions). Therefore, I use a more transparent approach, in which I first build up the covariance structure of preferences using normal distributions, and then transform the resulting distribution of channel utilities $\eta_j + Z_j\beta_{h,i} + \upsilon_{h,i,j}$ using $f_j(...)$. I specify $f_j(...)$ as

$$f_j(u) = u - \kappa_0 \frac{1}{1 + e^{\kappa_1(u - \eta_j^f)}}$$

where κ_0, κ_1 and $\eta_1^f ... \eta_J^f$ are free parameters. It nests the linear specification for $\kappa_0 = 0$. If κ_1 is large relative to the range of $u = \eta_j + Z_j\beta_{h,i} + \upsilon_{h,i,j}$, then $f_j(u) \approx u$ for u above the threshold η_1^f, but drops to $f_j(u) \approx u - \kappa_0$ below the threshold. This transformation allows me to match the proportion of heavy viewers and non-viewers without overpredicting the number of occasional viewers.

I do not have viewing data for some of the niche channels in the bundle. I specify the viewing utility for such channels as $U_{h,i,j,t} = \eta^{other} + \varepsilon_{h,i,j,t}$, where $\varepsilon_{h,i,j,t}$ is an i.i.d. logit shock.

Also, I observe a lot of cable viewing by non-subscribers in the data. This includes both local-antenna households watching cable channels, and cable subscribers watching channels that are not included in their subscription. To capture this in estimation, I allow consumers to watch channels they do not subscribe to ($j \notin S_h$), but their viewing utility for such channels is lower: it includes the disutility $\psi_j = \psi_0 + \psi^Z Z_j$ associated with having to get access to such channels outside the home. The ψ-s are free parameters in estimation.[60]

Outside alternative. The outside alternative $j = 0$ pools together two options: not watching TV and watching one of the broadcast networks (such as ABC, CBS, NBC or FOX). Notice that

[60] In preliminary estimation, I also allowed ψ_j to depend on consumer's demographics, however the coefficients on demographics were insignificant.

I do not have viewing data for the broadcast networks, so I do not explicitly model the viewing choices for them.

The outside utility is normalized to $U_{h,i,0,t} = 0 + \varepsilon^{out}_{h,i,t}$. Notice that this is a normalization (as opposed to a restriction), which is standard for discrete-choice models: the constant term and the coefficients on demographics have to be fixed for one of the alternatives.[61]

Two additional issues might be important in actual viewing behavior. One is switching costs and/or variety-seeking, which would introduce dependence in channel choices across periods. Another is joint viewing by multiple household members, which would introduce dependence in choices across individuals. Due to data limitations, I do not explicitly model such dependences, and they are captured in reduced form via the correlation structure of unobserved heterogeneity across channels for each individual and across individuals within each household.

Expected viewing utility for bundle S_h

Households' bundle choices are driven by the utility they expect to get from watching the channels in the bundle. The information and timing assumptions are the same as in the basic model (section 3.1).

The expected utility from bundle S_h at the subscription stage is

$$EU(S_h|X_{h,i}, w_{h,i}) \equiv E\left(\max\{U_{h,i,j,t}\}_{j\in\{S_h,0\}}|X_{h,i}, w_{h,i}\right)$$

For logit $\varepsilon_{h,i,j,t}$-s, it has an analytical expression (Ben-Akiva [1973])

$$EU(S_h|X_{h,i}, w_{h,i}) = \ln\left(\sum_{j\in\{S_h,0\}} \exp(\overline{U}_{h,i,j,t})\right) \tag{5.2}$$

where

$$\overline{U}_{h,i,j,t} \equiv U_{h,i,j,t} - \varepsilon_{h,i,j,t} = \begin{cases} f_j(\eta_j + Z_j\beta_{h,i} + \upsilon_{h,i,j}) \text{ for } j \in S_h \\ 0 \text{ for } j = 0 \end{cases}$$

In computing this expected utility, I restrict attention to the channels that are included in the bundle ($j \in \{S_h, 0\}$). Notice that the model of viewing choices above allows consumers to also watch channels they do not subscribe to, after incurring disutility ψ_j. A plausible alternative could be to compute expected utility for TV-viewing from all sources (with disutility ψ_j subtracted for channels $j \notin S_h$). I chose to focus only on the channels in the bundle for several reasons. First, the viewing by non-subscribers is mostly social viewing, thus ψ_j also captures the utility from its social aspects. Second, by focusing only on the channels consumers get in their subscription, it probably provides a more reasonable description of their actual subscription behavior. Finally, in preliminary estimation for a specification that nests both possibilities, the estimates supported focusing only on the channels in the bundle.

[61] Also, all bundles (including local antenna) include the same set of major broadcast channels, so I do not have to control for differences in broadcast channels across bundles.

5.2. Bundle Subscription Choice (Stage 1)

At the subscription stage, household h chooses from the list of available bundles. One possibility is to use the local antenna, which is free but only offers local broadcast channels (i.e., $S_h = \varnothing$). Another possibility is to subscribe to various combinations of packages and premium channels on cable or satellite.

A fully structural approach would be to compile the full list of all possible bundles for each household (all possible combinations of packages and premium channels on cable and satellite), and then compute expected viewing utilities and choice probabilities for each of the bundles on this list. However, the full list of all possible bundles contains hundreds of combinations,[62] which would slow down the estimation too much.

To reduce the number of combinations in estimation, I make several simplifying assumptions. First, I separate between the choice of main packages and the choice of premium channels. Specifically, I assume that consumers first choose the "main bundle": the combination of main packages such as basic, expanded-basis and digital-basic on cable. After that, in a separate step, they choose the premium channels such as HBO or Cinemax.[63] Second, instead of including in the choice set all possible satellite packages from DirecTV and Dish, I restrict attention to the most popular satellite package, DirecTV Total Choice.[64]

Choice of the "main bundle" (combination of packages)

Household h lives in a location served by cable system m. Her choice k is among the following mutually-exclusive combinations of packages: (1) local antenna, (2) basic cable, (3) basic + expanded-basic cable, (4) basic + expanded-basic + digital-basic cable, and (5) DirecTV Total Choice on satellite.

Each alternative $k = 1...5$ is characterized by the list of channels $S_{m,k}$ and price $P_{m,k}$.[65] The characteristics of cable alternatives (2)-(4) vary across cable systems m, while (1) and (5) are the same nationwide. The subscription-stage utility for alternative k is specified as

$$V_{h,k} = F(EU_1, ..., EU_{K_h}) + \alpha(X_h, w_h^p)P_{m,k} + \lambda_k W_h + \xi_{m,k} + \epsilon_{h,f(k)} \tag{5.3}$$

where $EU_i \equiv EU(S_{m,k}|X_{h,i}, w_{h,i})$ is the expected viewing utility for bundle k for each household

[62] Specifically, there are $2^6 = 64$ possible combinations of the premium channels in the data, and each of them can be matched with 3 possible combinations of main packages for a typical cable system, for a total of 192 possible cable bundles. The number of possible satellite bundles is in a similar range.

[63] Notice that the choice of main packages in the first step ignores the utility from subsequent premium subscriptions. This simplification can affect choices, for example if the relative ranking of the main packages plus HBO is different from the ranking of the same packages without HBO.

[64] Besides reducing the computational burden, another reason for using this assumption is that I do not observe specific provider and package for satellite subscribers in my data. An alternative could be to model choices for each satellite package separately, and then use the total for all satellite packages in estimation.

[65] In terms of notation, S_h in the previous subsection denotes the characteristics of the bundle actually chosen by household h, while $S_{m,k}$, $P_{m,k}$ in this subsection denote the characteristics of the k-th bundle available in the locations served by cable system m.

member $i = 1...K_h$, the function $F(...)$ aggregates household members' preferences, and $\alpha(X_h, w_h^p)$ is the price coefficient that depends on household demographics X_h and unobservable w_h^p. These parts of bundle utility are similar to the basic model (section 3.2), while the new terms $\lambda_k W_h + \xi_{m,k} + \epsilon_{h,f(k)}$ are discussed later. I specify $F(...)$ as

$$F(EU_1, ..., EU_{K_h}) \equiv (\phi_0 + \phi_1 K_h) \frac{1}{K_h} \sum_{i=1...K_h} EU_i$$

where the coefficients ϕ_0, ϕ_1 allow for some flexibility with respect to how household members' utilities are aggregated.[66] I specify the price coefficient as

$$\alpha(X_h, w_h^p) \equiv \alpha_0 + \alpha_{Inc} Inc_h + \alpha_w w_h^p$$

where Inc_h is household income and the price-sensitivity unobservable $w_h^p \sim N(0, 1)$.[67]

The new terms introduced in the empirical specification are $\lambda_k W_h + \xi_{m,k} + \epsilon_{h,f(k)}$. W_h denotes household characteristics that can affect bundle choices directly (i.e., not through the viewing utility).[68] The vertical characteristic $\xi_{m,k}$ captures several things. For cable companies, many decisions are made at the level of individual cable systems m, so $\xi_{m,k}$ for cable ($k = 2...4$) likely varies across systems (reflecting differences in customer service and marketing effort across systems), and also across bundles (reflecting the emphasis they place on different packages in their marketing and sales). For local antenna ($k = 1$) and satellite ($k = 5$), I assume that $\xi_{m,1} = \xi_1$ and $\xi_{m,5} = \xi_5$ everywhere, reflecting the average attractiveness of these options. For example, ξ_1 can capture the lower picture quality for local antenna, while ξ_5 can reflect the generally superior customer service for satellite (compared to cable) but also more complicated installation.[69]

Unlike in the basic model, in the empirical specification I also include idiosyncratic shocks $\epsilon_{h,f(k)}$, where $f(k)$ refers to the provider of the bundle: $f(k) = 1$ for local antenna, $f(k) = 2$ for any cable bundle $k = 2...4$, and $f(k) = 3$ for the satellite bundle. The $\epsilon_{h,f}$-s are i.i.d. logit shocks, which capture idiosyncratic preferences for specific providers. This is a hybrid specification following Song (2008), halfway between a pure-characteristics specification and random-coefficients logit. I use this specification because it fits the data better than a pure-characteristics specification (Berry

[66] Specifically, if $\phi_0 = 0$, $\phi_1 > 0$, then the subscription choices are driven by the *sum* of household members' utilities, if $\phi_0 > 0$, $\phi_1 = 0$, then they are driven by the *average*, and if $\phi_0 > 0$, $\phi_1 > 0$, then it is something in between. I also tried estimating different weights for different household members depending on their demographics, however the coefficients on demographics were insignificant.

[67] Normal distribution implies that a certain percentage of consumers will have a positive price coefficient. However this percentage in the final estimates is quite low (I truncate their price coefficient at a slightly negative value in counterfactuals, since otherwise the optimal price would be $+\infty$). I tried using log-normal and truncated normal distributions in estimation, however the resulting distribution looks very close to normal. Also, notice that the price coefficient for the least price-sensitive consumers is not identified from the data anyway.

[68] W_h only applies to satellite, and captures physical factors that affect satellite availability. Specifically, W_h includes DMA dummies and dummies for apartment building and rented house/apartment.

[69] Notice that satellite prices and packages are the same nationwide, reflecting a much more centralized structure. Thus, we are unlikely to have significant within-DMA variation in customer service and marketing effort for satellite providers (notice that $\lambda_k W_h$ captures the variation across DMAs).

and Pakes [2007]), and there are good a priori reasons to expect idiosyncratic shocks in preferences for different providers.[70] (Another possibility could be to use standard random-coefficients logit, which is more common than pure-characteristics specifications. However, as discussed in section 3.2, it would give unreasonable predictions in unbundling counterfactuals).

Choice of the premium channels

After choosing the main bundle (combination of packages), household h chooses premium channels. Consumers can subscribe to any combination of available premium channels, with fees around $10-15 per channel per month.

I use a reduced-form specification. Household h subscribes to premium channel $j = \{HBO, Cinemax, Encore, Showtime, StarZ, The\ Movie\ Channel\}$[71] with probability

$$Pr_{h,j}^{prem} = g(\eta_j^{prem} + (\phi_0^{prem} + \phi_1^{prem} K_h)\overline{U}_{h,j} + \alpha_{Inc}^{prem} Inc_h) \tag{5.4}$$

where $g(z)$ is a logistic function $g(z) \equiv \exp(z)/(1 + \exp(z))$, K_h is the household size, $\overline{U}_{h,j}$ is the average of household members' viewing utilities for channel j (excluding the logit shocks), and Inc_h is household income. Notice that the choices are not mutually-exclusive across channels.

I do not control for premium prices because of data quality issues in the Factbook. They are more severe for premium channels than for the main packages,[72] and as a result measurement error accounts for a large fraction of overall variation in premium prices.

5.3. Integrating out Unobserved Locations within the DMA

As mentioned in section 4.1, I do not observe household's exact location within the DMA. Thus, the cable system m that enters each household's choice set is unobservable to the researcher. In estimation, I use the standard solution of integrating out the unobservables (the cable system serving each household). I do it in several steps.

First, I use the 5 percent Census microdata (2000) to estimate the coefficients on household demographics for each location. The most detailed location variable in Census microdata is a PUMA (public-use microdata area), an area with population of around 100,000 people[73] (a city, part of a city, or several smaller communities combined). For each DMA, I estimate a multinomial logit of household's PUMA on household demographics.

[70] For example, the quality of local-antenna reception varies across households for idiosyncratic physical reasons. Likewise, in the same apartment building, an apartment facing south might have ideal physical conditions for satellite reception, while a next-door apartment facing north might have no clear line of sight to the satellite, making satellite reception physically impossible.

[71] All of them are available on satellite. For cable, availability varies across cable systems, so I restrict the set of channels if necessary. Households that chose local antenna cannot subscribe to any premium channels.

[72] One issue is a high proportion of missing or dubious prices. Also, some operators combine two premium channels into a single mini-package (e.g., StarZ + Encore), which is often not reported in the data. Finally, on many (but not all) cable systems consumers have to rent a set-top box for an additional fee in order to be able to get premium channels, and I do not observe which systems require that.

[73] Summary statistics from the Census are available at a much finer level of locations. However, this is not the case for publicly-available Census *microdata*, due to privacy concerns.

Next, I use these estimates to compute the predicted distribution of PUMAs for each household in the Simmons data. After that, I link PUMAs to the service areas of different cable systems, in order to obtain the probability distribution of cable systems for each household, $\Pr(m_h|X_h)$, conditional on household demographics X_h.

6. Estimation

I estimate the model using simulated GMM. All the moments are simulated in an unbiased way for each household, and the number of households is large, therefore the estimates are consistent for a small number of simulation draws.

For each household h, I observe its cable/satellite subscription variables, $Bundle_h$ for the main bundles ($Bundle_h = 1$ for antenna, 2...4 for the cable bundles, 5 for satellite), and $Prem_h$, a vector of six binary variables for premium subscriptions. For each individual $i = 1...K_h$ within household h, I observe demographics $X_{h,i}$ and a vector of viewing times $(T_{h,i,1}, ..., T_{h,i,64})$ for the 64 main cable channels, where $T_{h,i,j}$ denotes the total time spent watching channel j in the past 7 days. Also, for each household I have the estimated distribution of cable systems within the DMA, $\Pr(m_h|X_h)$, conditional on household demographics X_h (section 5.3).

6.1. Price Endogeneity

The unobserved vertical characteristics for cable bundles, $\xi_{m,k}$, are likely correlated with the price $P_{m,k}$. Without proper control for $\xi_{m,k}$-s, the price coefficient is likely to be biased upwards (e.g., Berry, Levinsohn, Pakes [1995]).

One standard solution for price endogeneity, BLP (Berry, Levinsohn, Pakes [1995]), is based on inverting the market shares in order to back out the $\xi_{m,k}$-s. However, this approach requires a large number of simulation draws in estimation, since the imputed ξ-s are not linear with respect to the simulation error. Furthermore, this approach requires multiple evaluations of predicted market shares within the contraction mapping loop at each iteration. This makes it computationally impractical in my case. The second standard solution in the literature, micro-BLP (Berry, Levinsohn, Pakes [2004]), is based on estimating the vertical constants $\delta_{m,k}$ for each product using micro-data, and then doing an IV regression of $\delta_{m,k}$-s on product characteristics and price. However, I do not have enough observations per cable system to reliably identify the $\delta_{m,k}$-s for each of the 140 cable systems in the data, so this approach is also not practical in my case.[74]

The most practical alternative is the control function approach of Petrin and Train (2010). Although there is some controversy around this approach (in particular, Wolak [2003]), Petrin and Train report that their estimates of price elasticity in the control-function approach are very close

[74] I have experimented with more restrictive specifications that can be identified from my data. Specifically, I allowed $\xi_{m,k}$-s to vary across tiers, DMAs and cable companies (but not across individual cable systems), and allowed them to depend on the observed characteristics of the system. However, this did not reduce the upward bias in the price coefficient, suggesting that price endogeneity is mostly due to unobserved variation across individual cable systems.

to BLP-type estimates. This approach is based on inverting the price equation to control for the unobservables that give rise to price endogeneity. Specifically, suppose that the price vector in market m can be approximated as $P_m = p(S_m) + \zeta_m$, where S_m is the vector of exogenous demand and supply shifters for all the products in this market, and ζ_m is the vector of product-specific price unobservables. Price endogeneity arises because the price residual ζ_m is in general correlated with the unobservable $\xi_{m,k}$ in the demand equation. However, if one backs out ζ_m from the price equation, and explicitly controls for it in the demand equation, price is no longer endogenous.

Following Petrin and Train (2010), I use a simple version of the control-function correction. Specifically, first I run OLS regressions of bundle price on demand and supply shifters, separately for basic, expanded-basic and digital-basic cable. The explanatory variables I use are the average demographics in the area served by cable system m, its channel capacity and availability of phone services (a proxy for its technology level), DMA dummies, dummies for the 5 largest cable companies, the number of cable channels on each tier and the total cost of license fees for each tier.[75] This gives me the estimates of the price residual vector $\widehat{\zeta}_m \equiv (\widehat{\zeta}_{m,basic}, \widehat{\zeta}_{m,exp\text{-}basic}, \widehat{\zeta}_{m,digital})$ for each cable system. After that, I estimate the full structural model, with $\xi_{m,k}$ specified as $\xi_{m,k} = \xi_k + \gamma_k \widehat{\zeta}_m$ for the cable bundles, where ξ_k and γ_k are free parameters in estimation.[76]

The main exclusion restriction that identifies the price elasticity parameter is that the total cost of the license fees for the channels in each tier (based on the average national license fees for each channel, not actual fees paid by a given cable company) has no direct effect on subscriptions, after accounting for the effect of these channels on the expected viewing utility. This requires some variation in the license fees across channels that is independent of their viewing utilities. There are several sources of such variation. First, the license fees are set in multi-year contracts, and therefore the current license fee for a given channel reflects its viewing utility at a point in time when the contract was last renegotiated, not its actual current viewing utility. Thus, for channels whose popularity was expanding rapidly during the sample period (e.g., FOX News), the contemporaneous license fees were not yet reflecting their increased popularity. Second, the degree of bargaining power varies across cable channels, reflecting their ownership structure. For example, as discussed in section 2.1, the owners of must-have programming commonly use wholesale bundling of channels to force cable operators to carry (and pay for) their less desirable channels. Finally, many of cable channels' programming costs (which affect the license fees they charge cable operators) are also set in multi-year contracts. For example, the current contract between ESPN/ABC and NBA is an eight-year contract that expires in 2016, and commits ESPN/ABC to pay NBA about

[75] Since the number of observations in these regressions is small (a total of 140 cable systems, some with missing prices) and the full list of explanatory variables above is too long, I tried various specifications for each regression and only kept the most relevant variables. Also, notice that my license-fees data (from SNL Kagan [2007]) represents national averages for all cable companies, so the cable company dummies help capture the differences in actual fees paid by different cable companies.

[76] Notice that all 3 residuals enter $\xi_{m,k}$ for each cable bundle. Also, the true specification is not necessarily linear, so a more flexible polynomial approximation can be used. Petrin and Train find that a simple linear specification works well for cable television.

\$930 million a year for the broadcast rights.[77] Thus, the costs of NBA programming for ESPN between 2008-2016 reflect their expectations of NBA popularity as of 2007, not its actual popularity between 2008-2016. Due to these reasons, part of the variation in the license fees across channels is unrelated to their actual viewing utilities.

6.2. The Moments

I match several groups of moments in estimation. The details of simulation and computation are in appendix A.

The first group of moments is the viewing-time moments. For each of the 64 channels, I match actual and predicted average viewing time, and predicted and actual proportion of non-zero viewing time. This pins down the vertical constants η_j, η_j^f for each channel.[78] Also, I match the covariances between viewing choices and demographics, multiplied by observed channel characteristics (summed over all channels to reduce the number of moments). This pins down the coefficients on demographics β in viewing preferences. To identify ψ_0, ψ^Z, I match the covariance between viewing time for channel j and binary variables for whether or not it is available on basic, expanded-basic and digital cable in household's location, and covariances with the same binary variables multiplied by channel characteristics (summed over all channels to reduce the number of moments).

For each channel j, I also match actual and predicted covariances between the viewing time for channel j and the rest of the channels combined. For each pair of channels j, k (among the top-32 channels for which I estimate the factor-analytic term $\Pi_j \omega_{h,i}^{\Pi}$), I match actual and predicted covariances between the viewing times for those two channels.[79] These covariances pin down the unobserved heterogeneity parameters Ω and Π_j. To identify the within-household correlation parameter ρ, I also match predicted and actual covariances of total viewing time between different household members.

The second group is the subscription choice moments. For the main bundle choices (antenna; basic, expanded-basic and digital cable; satellite), I match actual and predicted shares for each of the main bundles, and covariances between bundle choices and: household demographics, bundle characteristics (including price[80]) and interactions between bundle characteristics and demographics. This pins down the parameters in bundle utility (5.3). For premium subscriptions, I match actual and predicted shares for each of the premium channels, and their correlations with household demographics. This pins down the parameters in premium choice probability (5.4).

The third group of moments is covariances between viewing choices and bundle choices. Specifically, for each of the main bundles, I match the covariance between viewing times and

[77] *USA Today*, May 26, 2007. http://www.usatoday.com/sports/basketball/2007-06-27-3096131424_x.htm

[78] Of course, all parameters are identified from multiple moments, so I only refer to the most direct link between the moments and parameters.

[79] Since covariances $cov(T_j, T_k|...)$ cannot be simulated in an unbiased way, in actual estimation I match $E(T_j, T_k|...)$ instead. This applies to all the covariances in this subsection. Notice that $E(T_j|...)$, $E(T_k|...)$ are also matched in separate moments, so this is equivalent to matching the covariances.

[80] Notice that the price and price residual are valid instruments in the control-function approach.

bundle choices, and the covariances between viewing times and bundle characteristics interacted with bundle choices. This captures the effect of consumers' self-selection into different bundles based on their unobserved preferences.[81] Similarly, I match the covariances between premium subscriptions and viewing time for premium channels, which captures the effect of self-selection into different premium subscriptions.

6.3. Additional Issues in Estimation and Identification

Characteristics of cable bundles as instruments

Since I do not observe household's exact location within the DMA, I specify the bundle characteristics instruments for each household as the expected value of bundle characteristics computed using the distribution of cable systems $\Pr(m_h|X_h)$ for this household, where X_h represents household demographics. Notice that this expectation varies across households, and it is correlated with their actual choices. For example, a household that is more likely (based on its X_h) to live in areas with attractive cable bundles is also more likely to subscribe to cable. Likewise, a household that is more likely to live in areas where channel j is available on cable is more likely to watch this channel.

One concern might be that the expectation of bundle characteristics is a function of household demographics X_h, and the same X_h also affects viewing choices and bundle choices directly, via the viewing utilities. However, notice that the effect of X_h on the expected bundle characteristics is a *DMA-specific* function (roughly, an interaction between X_h and bundle characteristics for different locations within the DMA). In contrast, the direct effect of X_h via the viewing utilities is the same for all DMAs.

Basic-only vs basic plus expanded-basic subscriptions

The Simmons data does not distinguish between basic-only and basic plus expanded-basic cable subscriptions (both are recorded as "analog cable"). In estimation, I compute choice probabilities separately for basic cable ($k = 2$) and basic plus expanded-basic cable ($k = 3$), and match the combined probability for analog cable. To pin down the share of basic-only subscribers, I match the predicted share of basic subscribers to its actual share from other sources (12% of all cable subscribers nationwide, FCC [2005a]).

One issue with this is that much of the variation for major cable channels is with respect to their placement on basic vs expanded-basic tier (section 4.2). For example, if many consumers only value ESPN (typically carried on expanded-basic), then the share of basic-only subscribers will be much higher for the systems that offer ESPN on the basic tier. Since I do not observe basic-only subscriptions separately from expanded-basic subscriptions, it could be a problem if the changes

[81] For example, consider two locations with identical channel lineups for all cable bundles and identical prices for basic and expanded-basic cable, but different prices for digital basic. Conditional on demographics, the households that choose digital cable in the more expensive location are those with higher unobserved viewing preferences. Therefore, the viewing time among digital-cable subscribers will be positively correlated with the price of digital cable.

in the basic-only share are mostly at the expense of expanded basic. However, this is unlikely to be the case. Specifically, if ESPN is placed on basic cable (i.e., in order to get ESPN, consumer has to pay around $18, compared to around $45 in the typical case), the basic-only share will also increase at the expense of local antenna and satellite.

Large number of moments in estimation

The number of moments in estimation is large (about 1100). The main reason is that I have a large number of dependent variables for each household, specifically viewing times for 64 channels, 5 mutually-exclusive bundle alternatives, and choices for 6 premium channels. The large number of moments can affect the performance of GMM.

Hansen, Heaton and Yaron (1996) show that standard two-step GMM performs poorly when the number of moments is large relative to the sample size. The reason is that the *estimated* optimal weighting matrix for the second step is not estimated accurately if the number of moments is large. Therefore, instead of using two-step GMM, I use less efficient but more reliable one-step GMM (I rescale the moments so that they are roughly the same order of magnitude).

Also, Stock and Wright (2000) and Phillips and Han (2006) show that GMM asymptotics can break down when the number of moments is large but the moments are weak. However, the moment conditions in my data are not weak. In particular, one set of moments matches the predicted and actual average viewing times for the 64 channels, and the covariances between viewing choices and a small number of key demographic variables (those demographics are highly significant predictors of viewing choices in preliminary reduced-form analysis). Another set of moments matches the covariances of viewing times between channels. Another set of moments matches predicted and actual average subscriptions, and the covariances between subscriptions and a small number of key demographics and cable package characteristics (which are highly significant predictors of subscriptions in reduced-form analysis).

To evaluate the finite-sample properties of my estimation procedure, I conducted several Monte-Carlo estimation runs, generating artificial data and then estimating the full structural model from this data. The point estimates were reasonably close to the true values, and the reported standard errors were reasonable.

7. Empirical Results

The estimates are presented in table 4. First, I check whether the estimates are reasonable, and evaluate the fit of the model. Most of the parameters are of the expected sign. For example, viewing utility for ESPN is significantly higher for men, Lifetime for women, BET for African-Americans, while the utility for CNN is increasing with age and education. Expected viewing utility has a significant positive effect on bundle choices ($\widehat{\phi}_0 = 49.8$ (8.4), $\widehat{\phi}_1 = 2.7$ (0.9)). The units of expected utility are not directly interpretable, so I check what happens to predicted subscriptions when I remove one channel from the expanded-basic package, keeping the prices fixed.[82] For example, when I remove CNN, expanded-basic subscriptions drop by 6.1% (3.1 percentage points), and satellite gains 14.4% (2.8 percentage points), with slight gains for local antenna and basic cable. The magnitudes for other major channels (Discovery, ESPN, TBS, TNT) are comparable, with a loss of 4.7%-6.8% for expanded-basic and a gain of 11.4%-16.7% for satellite.

Own price elasticity is -2.09 for basic cable, -2.98 for expanded-basic and -2.21 for digital-basic (average for all cable systems in the data), which is quite similar to the estimates in the literature.[83] The closest substitute for expanded-basic cable is digital cable (with a cross price elasticity of 1.58, vs 1.32 for satellite), and the closest substitute for digital cable is expanded-basic cable (the cross price elasticity is 1.52, vs just 0.18 for satellite[84]). When I re-estimate the model without controlling for price endogeneity, the estimates of price elasticities are much closer to zero (-1.1 for basic, -1.3 for expanded-basic and -0.05 for digital), as expected.

The crucial assumption in my approach is that the unbundled channel subscriptions are driven by the expected viewing utilities. To evaluate whether this assumption is appropriate, I compare predicted and actual subscriptions for HBO, for which I observe actual unbundled subscriptions in the data. I set the price of HBO to \$10, similar to the average price in the data. To compute predicted HBO subscriptions, I explicitly model subscription choices for 4 cable bundles (in addition to local antenna and satellite): basic cable, basic + expanded-basic, basic + HBO, and basic + expanded-basic + HBO. After computing expected viewing utility for each bundle, I compute the subscription probabilities based on the structural model. The predicted HBO subscriptions are 23% of all cable subscribers, remarkably close to the actual subscriptions in the data (24%).[85]

Next, I evaluate the fit of the model. I simulate subscriptions and viewing choices based on the estimates, and compare them to the actual distributions in the data. In figure 2, I plot predicted and actual mean viewing time and proportion of non-zero time for each channel. The fit is quite good. Next, the most important determinant of discriminatory effects of bundling is the covariance structure of channel preferences. In figure 3, I plot predicted and actual covariances of viewing times for each pair of the 64 channels in the data. The fit of covariances for the 32 most popular channels (for which I estimate the factor-analytic component $\Pi_j \omega^{\Pi}_{h,i}$) is quite good. For the fringe channels (for which I do not estimate $\Pi_j \omega^{\Pi}_{h,i}$), the fit of covariances is naturally less good, but still reasonable. Besides covariances between individual channels, another useful measure is the

[82] I compute it for a somewhat simplified cable system, which offers a broadcast-only basic and a "representative" expanded-basic package, without a separate digital tier.

[83] Some examples of estimates of own price elasticity for cable are: -2.19 in FCC (2002), -3.22 in GAO (2003), -1.5 for expanded-basic cable and -3.2 for premium cable in Goolsbee and Petrin (2004).

[84] Low substitution from digital cable to satellite is quite plausible. While the price of expanded-basic cable is roughly the same as satellite, digital cable is substantially more expensive (even though its channel lineup is usually inferior to satellite). Thus, consumers who get digital cable are those with disproportionately low preferences for satellite relative to cable (for example, they cannot get satellite reception for physical reasons).

[85] Notice that my estimation approach does not artificially force predicted HBO subscriptions to be close to actual subscriptions. In particular, I use a reduced-form specification for premium subscriptions in estimation, while the predicted HBO subscriptions in this counterfactual are based on a fully-structural model, in which HBO subscriptions are explained entirely by HBO's effect on expected viewing utility relative to its price.

covariance between each channel and the rest of the channels combined (figure 4). It determines the effect of including channel j in a typical bundle in the data. The fit is also quite good.

I also compare my estimates of the correlation matrix of channel WTPs to those reported in the parallel paper by Crawford and Yurukoglu (2008). In figure 5, I plot the pairwise correlations in channel WTPs based on my estimates (the horizontal axis) against those in Crawford and Yurukoglu (the vertical axis), for all pairs of channels that overlap between our papers. My estimates of correlations in channel WTPs are moderately higher than those in Crawford and Yurukoglu (2008): the average correlation is 0.281 vs 0.197 in Crawford and Yurukoglu, and the median is 0.276 vs 0.240. However, the correlation between our estimates is just 0.074, indicating substantial differences between our estimates of the key parameters driving the magnitude of discriminatory effects of bundling. Furthermore, the proportion of negatively-correlated WTPs in my estimates is much lower, just 2.1% vs 30.7% in Crawford and Yurukoglu. This difference is essential, since bundling of channels with negatively-correlated WTPs has the strongest discriminatory effect. Based on these differences in the estimates of the correlation structure of channel WTPs, my estimates of welfare gains from unbundling are likely to be substantially weaker than those found by Crawford and Yurukoglu. Notice that my estimates are based on individual-level data, which yields much more reliable estimates of the correlation structure of channel WTPs than the market-level data used in Crawford and Yurukoglu (2008).

Next, I conduct counterfactuals to evaluate the likely short-run effects of unbundling for consumers, cable networks and cable operators.

7.1. General Structure and Assumptions in Counterfactuals

Under bundling, consumers face two cable alternatives: (1) basic cable, which only includes the broadcast networks, and (2) basic cable plus the full cable bundle.[86] The cable bundle contains all the non-premium channels offered by at least half of all cable systems in the data (a total of 54 cable channels), and its channel lineup is somewhere between a typical expanded-basic and digital bundle. Consumers can also choose local antenna or satellite.

My main unbundling scenario is "themed tiers" (section 7.2), in which I break up the cable bundle into 7 mini-tiers by channel genre. This is one of the main unbundling scenarios advocated by FCC (2006). All cable subscribers are required to get basic cable in this scenario, since all practical discussions of unbundling include this requirement. In addition to basic cable, they can choose any combination of the mini-tiers. I also consider an additional unbundling scenario, with mini-tiers based on channel owner (section 7.3).

I do not consider the option of "full a la carte" (unbundling to the level of individual channels), for computational reasons. Specifically, while I can compute optimal a la carte subscriptions

[86] I do not include a separate digital tier (offered by most cable systems and purchased by 35% of cable subscribers) to be able to isolate the effects of bundling in a more transparent setting. I include a separate basic tier (offered by almost all systems in the data) under bundling to allow for a clean comparison with the unbundled scenarios (which involve unbundling only for the tiers above basic cable, as discussed later).

for each household at given channel prices, the resulting profit function is not differentiable, due to discrete jumps in households' subscriptions in response to a change in prices.[87] This substantially complicates the computation of optimal channel prices under a la carte.[88] Also, given the much higher complexity of choices under a la carte, consumers' cognitive constraints might become important, making predictions less credible.

In unbundling counterfactuals, I assume that all cable alternatives (basic cable plus any combination of the mini-tiers) have the same vertical constant ξ, so the choice among them is driven entirely by the differences in expected viewing utilities and prices. I set their ξ equal to the ξ of the most popular bundle in the data, basic plus expanded-basic. This amounts to some improvement in the ξ for basic cable relative to the estimates. However, such an improvement is quite plausible under unbundling. In particular, from conversations with industry executives, many cable systems strive to make basic cable as invisible as possible, steering consumers' attention to other, more expensive bundles.[89] Under unbundling, consumers' choices are framed explicitly as basic cable plus any combination of the mini-tiers, so the visibility of basic cable is likely to be much higher. To make the outcomes under bundling comparable to the unbundled case, I set the ξ for basic cable at the same level.

In all cases, I assume that satellite does not react to cable unbundling, i.e., satellite packages and prices do not change. Since satellite packages and prices are the same nationwide, this assumption is plausible for counterfactuals affecting relatively few cable systems (for example, a limited-scale pilot project designed to evaluate the effects of unbundling, or unbundling forced by the local authorities as part of franchise negotiations). Notice that cable operators make many decisions at the local level, so counterfactuals focusing on an individual system are meaningful. In principle, I could conduct counterfactuals with re-optimization by satellite, however the results would be much less credible due to data limitations.[90]

I focus on a "representative cable system" for the 4 DMAs used in estimation (Boston, Los Angeles, New York and San Francisco), i.e., I assume that the distribution of demographics in the area served by this system is the same as the distribution for those 4 DMAs combined. I assume that this cable system is not vertically integrated with any of the cable networks, i.e., it does not internalize the effect of its decisions on the networks' revenues. Besides license fees to the networks,

[87] For mini-tiers, I use a different computational approach, in which I explicitly compute (differentiable) choice probabilities for each possible combination of the mini-tiers. However, this approach is not feasible for a la carte, since there are $2^{54} \approx 1.8 \times 10^{16}$ possible combinations of channels.

[88] It requires nonlinear search in 55 dimensions, with a non-differentiable objective function. I tried using the Nelder-Mead method, which does not rely on derivatives, however it tends to get stuck in local maxima, and the results are highly sensitive to the starting values. One feasible option is to constrain all channel prices to be the same. The main results in this case are similar to those for mini-tiers.

[89] Notice that regulation forces them to offer relatively cheap basic packages at regulated prices. As a result, basic cable is rarely mentioned in their advertising. Also, it appears that their sales representatives are often instructed to not mention the option of a basic-only subscription at all, unless explicitly asked about it.

[90] For satellite subscribers in the data, I do not observe whether they get DirecTV or Dish, therefore the substitution patterns between the two satellite providers are not identified from the data. Also, since there is no price variation for satellite, its price elasticity is identified only through functional form assumptions.

I assume that the cable operator has an additional marginal cost of $3 a month per subscriber (this covers a typical franchise fee and fees to broadcast networks), while all other expenditures are fixed costs.

Unbundling is likely to increase cable operator's equipment and customer-service costs (for example, see Booz, Allen, Hamilton [2004] for reasons why they will increase substantially, or FCC [2006] for reasons why they will not). Since it is not clear how much they will increase (and whether this will affect marginal or fixed costs), I assume that these costs do not increase at all, which represents the best-case scenario for unbundling.

Besides subscription fees, cable operators get revenues from their share of advertising time ($4.60 a month per subscriber on average, FCC [2005a]). I do not have data on cable networks' advertising rates (also, the *local* advertising rates relevant for cable operators might be systematically different from the networks' national rates). I divide the average advertising revenue of $4.60 by the average viewing time to get a rough estimate of advertising revenue per viewer-hour, which enters cable operator's profit-maximization.[91] This approximation is obviously quite crude, however advertising accounts for a small share of cable operators' revenues (about 6%).

In counterfactuals, cable operator chooses the optimal retail prices for basic cable and each of the mini-tiers, taking the structure of its programming costs (license fees to the cable networks) as exogenously given. As discussed in section 2.2, networks' license fees per subscriber are likely to increase a lot after unbundling. In unbundling counterfactuals, first I compute the outcomes for the original license fees per subscriber in the data (from SNL Kagan [2007]), and then for several alternative scenarios for the programming costs.

Sanity check: Bundling benchmark

I present predicted outcome under bundling (for actual license fees in the data) in column (a) of table 6. The optimal prices are $23.13 for basic cable (vs $18.08 on average in the data), and $46.64 for the full bundle (vs $45.32 for basic + expanded-basic in the data). The predicted market shares are 7.0% for basic-only cable (same as in the data), 47.3% for the full cable bundle (vs 50% for expanded-basic cable and above in the data), 24.4% for local antenna (vs 23%) and 21.3% for satellite (vs 20% in the data). With the exception of basic price, which is often regulated, predicted outcomes are reasonably close to actual outcomes. Notice that I do not use any supply-side conditions in estimation, and I have data on marginal costs, so I do not have to back them out from supply-side conditions. Thus, nothing in the estimation procedure artificially forces the optimal prices to be close to the actual prices. Consequently, the comparison of actual and optimal prices represents a useful empirical sanity check for the estimates.[92]

[91] Notice that the cable operator maximizes total profits from subscriptions and advertising, so advertising affects its optimal choice of retail prices. When computing the optimal prices, for each price vector I explicitly compute not only predicted subscriptions but also viewing choices by cable subscribers, which determines cable operator's advertising revenues.

[92] In contrast, if I relied on the optimal pricing conditions in estimation, or to back out the marginal costs, the same sanity check would only indicate that the codes are free of bugs.

7.2. "Themed tiers" unbundling counterfactual

In this counterfactual, I break up the cable bundle into 7 "themed tiers" based on channel genre (see table 5a for the channel lineups for each "themed tier"). First, I compute the "themed tiers" outcome for the original license fees per subscriber in the data. Although the license fees are unlikely to remain the same, it provides a natural starting point. The results are in column (a) of tables 7a, 7b, and the parallel bundling outcome is in column (a) of table 6.

The optimal prices of the mini-tiers range from \$0.20 for women's programming to \$6.97 for "general entertainment" and \$9.27 for sports.[93] Notice that all mini-tier subscribers also have to pay the basic fee, which is quite substantial at \$29.01 (vs \$23.13 under bundling). 54.3% of consumers get at least one mini-tier, vs 47.3% getting the full bundle under bundling. The mini-tiers gain subscribers at the expense of local antenna (which loses 0.7 percentage points relative to bundling), basic-only cable (3.9 percentage points) and satellite (2.4 percentage points). On average, cable subscribers get 3.5 mini-tiers out of 7.[94] The most popular tiers are "general entertainment" (70% of cable subscribers), "education/learning" (66%) and "news/information" (60%), and the least popular ones are "movies" (26%) and "sports" (27%). For comparison, under bundling 87% of cable subscribers were getting the full bundle, so the networks on all mini-tiers lose subscribers.

The predicted proportion of sports tier subscribers (27%) in this scenario might seem suspiciously low. However, it is consistent with survey evidence from multiple sources. For example, a USA Today poll conducted in 2006 found that "just 28% of Americans would pay a fee to buy a sports programming package that included ESPN".[95] Likewise, a Consumers Union poll found that only 22% of respondents would be willing to pay \$2 per month to get ESPN if they were given the choice (the parallel prediction based on my structural estimates is about 30%).[96] Similarly, Cox Cable estimates that less than 25% of their subscribers are "avid sports fans".[97]

Cable operator's profits increase by 16% after unbundling. The main reason for this is a sharp decrease in the total cost of cable programming. For example, the cost of license fees for the sports channels is \$4.33 per subscriber. Under bundling, the cable operator incurs this cost for 87% of its subscribers (all the full-bundle buyers), but under "themed tiers", only for the 27% who get the "sports" tier.[98] Unbundling reduces cable operator's average programming costs per subscriber from \$11.29 to \$6.43. At the same time, average revenue per subscriber drops by just

[93] Notice that a change in the price of a mini-tier affects not only its own subscriptions, but also subscriptions to basic cable and other mini-tiers. As a result, the optimal retail markups differ across the mini-tiers. Furthermore, in some cases (e.g., "women's programming" mini-tier) the optimal markup turns out to be negative. The reason is that lowering the price of this mini-tier generates sufficiently large additional revenues from basic cable and other mini-tiers.

[94] I also computed the mixed-bundling scenario, in which consumer can get either mini-tiers or the full bundle (at a discount relative to the unbundled prices). However, the optimal discount on the full bundle is small, and very few consumers choose the full bundle. Thus, the mixed-bundling outcome is almost identical to the "pure unbundling" case analyzed in this section.

[95] Source: http://www.usatoday.com/tech/news/2006-03-01-ala-carte-cable_x.htm

[96] Source: http://www.consumerfed.org/elements/www.consumerfed.org/file/mpcableindustry.pdf

[97] Same source as in previous footnote.

[98] Of course, the license fees per subscriber are likely to go up in this case. I consider this case later.

$1.34, and the total number of subscribers increases slightly.

The main outcomes of interest in this counterfactual are: (1) the welfare effects for consumers (since the push for unbundling is based on the argument that consumers would gain a lot from unbundling), and (2) the outcomes for the networks (since one of the main concerns about unbundling is that it can destroy the economic foundations of the cable networks).

Outcomes for consumers

The average cable bill for the mini-tier subscribers (excluding basic-only subscribers) is $43.03, 7.7% less than the original price of the full bundle. However, they also get fewer channels (half of the mini-tiers on average). This may reduce welfare, since the consumers who got the full bundle under bundling are no longer getting the mini-tiers they value at above zero but below the unbundled price. Also, the price of basic cable goes up, hurting basic-only subscribers. On the other hand, the mini-tiers attract new consumers who were not getting cable programming under bundling, which may increase welfare. By explicitly linking bundle choices to viewing utilities, the model allows me to measure the combined effect of the change in prices and the change in access to cable programming.

On average, consumers gain slightly from the switch to "themed tiers", but the average increase in consumer surplus is just 35 cents per household per month.[99] Notice that this is an absolute best-case scenario for unbundling: it assumes that cable operator's equipment and customer-service costs do not go up at all after unbundling, and that the networks do not increase their license fees per subscriber despite the loss of subscribers. Thus, even the best-case gains to consumers are minimal. Furthermore, when I look at the distribution of welfare gains and losses from unbundling, I find that consumers who lose from unbundling are disproportionately larger, poorer households.

One reason consumers do not save much from unbundling is that the optimal basic fee is $29.01, almost two-thirds of the original bundle price. In practice, the price of basic cable is often regulated. In column (b) of tables 6, 7a, 7b, I impose price regulation, setting the price of basic cable at $15. Cable operator responds to price regulation by charging higher prices for the mini-tiers. The gain in consumer surplus (relative to bundling with the same price regulation) is still minor, 73 cents per household per month. Also, notice that the cable operator can easily bypass the price regulation for basic cable, for example by requiring all mini-tier subscribers to get a converter for an extra fee.[100] Therefore, I do not impose price regulation in the rest of counterfactuals.

[99] I measure welfare changes for each household as the change in expected bundle utility ($E\{max\}$ for equation (5.3)), divided by the price coefficient. In computing this change, I hold the unobservables ω_h, ω_h^P constant, but integrate out the draws of the logit shocks $\epsilon_{h,f}$ (since they vary across different bundle choice occasions, unlike ω_h, ω_h^P).

In many cases, an important concern about empirical welfare measures is that we do not observe consumers' maximum willingness to pay for a given good (e.g., see the discussion in Goolsbee and Petrin [2004]). However, this concern does not apply in my case, since after unbundling consumers still have access to the same set of channels, and the only thing that changes is the prices they face for different combinations of channels.

[100] The price of basic cable (including fees for any equipment required to receive it) is regulated on public-interest grounds, to give consumers access to the broadcast networks at affordable prices. This justification would not apply

Outcomes for the networks

The outcomes for the networks (without price regulation) are in column (a) of table 7b. Cable networks have two sources of revenue, license fees per subscriber and advertising, coming from both cable and satellite. As mentioned earlier, I assume that unbundling only applies to cable but not to satellite, so first I focus on the outcomes for the networks only among cable subscribers. Although cable gains market share after unbundling, the networks on all mini-tiers lose subscribers, dropping by 40% on average. This is not surprising, since most consumers watch only a small fraction of the channels in the bundle. Despite the sharp drop in the number of subscribers, viewership among cable subscribers increases slightly, by 1%. Networks' total revenues from cable (license fees and advertising revenues) drop by 18% on average.[101]

All mini-tiers lose revenue, but some are affected much more than others. The least-affected tiers are "general entertainment" and "education/learning", which still see a 15-20% drop in the number of subscribers, combined with slight increases in viewership (1-3%). The worst-hit tier is "sports", with a drop of 68% in the number of subscribers and a 19% drop in viewership. The main reason is that sports channels have disproportionately high license fees (they account for 33% of the total license fees for the full bundle, but just 10% of viewership – table 5a). As a result, the optimal retail price of the sports tier ($9.27) is high enough to exclude many of the occasional sports viewers. Satellite share declines slightly after unbundling, so networks' revenues from satellite also drop a little.

Thus, if the networks' license fees per subscriber do not increase at all after unbundling, consumers would benefit slightly in the short run, but the networks' revenues would decline substantially, reducing their ability to invest in programming. This is likely to harm consumers in the long run.

7.2.1. Proportional increase in the license fees

Given the decline in the number of subscribers after unbundling, the networks are likely to increase their license fees per subscriber. For simplicity, I assume that the networks increase their license fees proportionally to the loss of subscribers in the "themed tiers" counterfactual above. After that, the cable operator re-optimizes its retail prices, taking the new license fees per subscriber as given. Notice that such an increase in the license fees does not fully compensate the networks, since the number of subscribers is likely to decline further after the re-optimization of retail prices. Still, it provides a simple lower bound on how much the license fees would have to increase in order to keep the networks' revenues at the same level as they were before unbundling.

The results are in column (e) of tables 7a, 7b. The optimal prices of most mini-tiers go

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to additional equipment required to receive the mini-tiers.

[101] I do not have data on networks' advertising rates. On average, networks get about half of their revenues from advertising and half from license fees. I assume that the advertising revenue per viewer-hour is the same for all networks (which is clearly a crude approximation). The rate per viewer-hour is calibrated so that advertising accounts for 50% of the networks' total revenue in the original bundling outcome.

up.[102] The largest price increase is for the sports tier, because its license fees more than triple (from \$4.33 to \$13.37 per subscriber). Its retail price increases from \$9.27 to \$37.01, and sports tier subscriptions drop from 27% to 11% of all cable subscribers. Networks' revenues are still substantially lower than they were under bundling. The increase in the license fees partially offsets the loss of subscribers, but higher retail prices also reduce viewership and advertising revenues, especially for the sports tier.

On average, consumers are worse off than they were under bundling: average consumer surplus drops by \$2.43 per household per month.

7.2.2. Alternative License Fee Arrangements

Based on the results above, unbundling is likely to substantially reduce networks' license-fee revenues. Also, if the networks increase their fees per subscriber to try to offset the loss of subscribers, it creates substantial inefficiency due to double-marginalization (notice that the cable operator adds its retail markup without any coordination with the networks[103]).

One way to preserve networks' revenues without creating substantial inefficiency is to replace the current fee-per-subscriber arrangement with a more efficient upstream arrangement such as lump-sum fees or revenue-sharing.

Equivalent lump-sum fees

Since the networks' marginal costs per subscriber are zero, the most natural alternative arrangement would be to switch to lump-sum payments. I assume that the cable operator pays each network a lump-sum fee equal to its total license-fee revenues under bundling. The results are in column (c) of tables 7a, 7b.

The optimal prices of most mini-tiers decrease somewhat, because the marginal costs for the cable operator are now zero. The optimal price of basic cable increases to \$30.12. 57.4% of consumers now get at least one mini-tier, vs 54.3% under the original license fees scenario. The most popular mini-tiers are still "general entertainment" (74% of all cable subscribers) and "education/learning" (64%), and the least popular tiers are still "movies" (28%) and "sports" (36%). Cable operator's profits are 4.3% higher than they were in the original bundling outcome (column (a) of table 6).

Average consumer surplus increases by \$1.63 per household per month, relative to the original bundling outcome. However, these gains are not due to unbundling per se, but entirely due to the switch to a more efficient upstream arrangement. When I compute the outcomes for a similar lump-sum arrangement under bundling, the gain in consumer surplus is even larger, \$1.89 per household per month on average (column (c) of table 6).

[102] There are several exceptions, for which the optimal price actually declined despite the increase in the license fees. This is not unreasonable, since there are interaction effects: the price of each mini-tier also affects revenues from basic cable and other mini-tiers.

[103] This assumption in counterfactuals is consistent with the actual arrangements between the networks and cable operators.

Compared to the original bundling outcome, total viewership for the cable networks is slightly higher (column (c) of table 7b). Their license-fee revenues from the cable operator are the same as earlier, but they get lower revenues from satellite since its market share is now lower (recall that I assume the satellite provider keeps offering its original bundle at the original price, and it stays with the original license-fee arrangements). As a result, networks' total revenues drop by 2%.

This scenario benefits consumers without significantly harming the networks. However, as mentioned above, these gains are driven by the elimination of double-marginalization, while the net effect of unbundling itself is negative. Thus, the main way in which unbundling can potentially benefit consumers is if it forces the industry to switch to more efficient lump-sum arrangements in the upstream market. For some reason, the industry does not use such arrangements now (with a few exceptions[104]), however unbundling might make them relatively more attractive for the networks. Also, if cable operator's equipment and customer-service costs increase after unbundling (which is likely), the gains from a switch to lump-sum fees combined with unbundling would be lower than found above.

Revenue-sharing

Another alternative is to use revenue-sharing. The most natural revenue-sharing scheme, paying the networks a fixed percentage of revenue from their mini-tier, is vulnerable to manipulation. Specifically, cable operator optimally sets the mini-tier prices close to zero, to reduce the payments to the networks, and increases the basic fee which is not shared with the networks.[105] Therefore, I use a simpler arrangement, in which each network gets the same share of total subscription revenue (from all mini-tiers and basic fees) as it was getting in the original bundling scenario.

The results are in column (d) of tables 7a, 7b. The outcomes for consumers, cable operator and the networks are quite similar to those for the lump-sum fees. Compared to the original bundling outcome, average consumer surplus increases by $1.90 per household, slightly higher than in the lump-sum case. However, like in the lump-sum fees scenario above, the gains are due to the switch to a more efficient license-fee arrangement, not due to unbundling. When I compute the parallel outcome under bundling, the gain in consumer surplus is even higher. Thus, again the main way in which unbundling can potentially benefit consumers is if it forces the industry to switch to a more efficient upstream arrangement, while the net effect of unbundling itself is negative.

7.3. Mini-Tiers by Owner

Another plausible way to structure the mini-tiers is based on channel ownership. Specifically, I set up 5 mini-tiers that correspond to the channels owned by each of the 5 largest media companies (Disney, Time Warner, News Corp., NBC Universal, Viacom), plus another mini-tier for the remaining channels (see table 5b for channel lineups). This scenario might be easier to implement

[104] SNL Kagan (2007) reports several recent lump-sum deals between an (unnamed) satellite operator and several (unnamed) cable networks.

[105] Since most consumers buy multiple mini-tiers, there is no clear way to trace the basic-fee revenues generated by a specific mini-tier.

than “themed tiers”, because it does not require breaking up the existing wholesale bundles of channels.[106] The results are in tables 8a, 8b.

The main results are similar to those for the “themed tiers”. For the original license fees in the data (column (a)), consumers gain slightly from unbundling, but the increase in consumer surplus is just 31 cents per household per month. All mini-tiers lose subscribers, so the networks' license-fee revenues drop substantially. On the other hand, viewership (advertising revenue) does not change much. If the networks increase their license fees proportionally to the loss of subscribers (column (e)), unbundling would reduce the average consumer surplus. Consumers gain if unbundling is combined with a lump-sum or revenue-sharing arrangement in the upstream market (columns (c) and (d)), but the net effect of unbundling itself is minimal, and most of the gains are due to the switch to a more efficient upstream arrangement.

7.4. Discriminatory Effects of Bundling

Discriminatory effects are one of the main theoretical explanations for the widespread use of bundling, and one of the main mechanisms through which unbundling might benefit consumers. To isolate the discriminatory effects of bundling, I set cable operator's advertising revenues to zero and the license fees to zero. This way, I can check whether bundling facilitates surplus extraction by the firm relative to unbundled sales (this is the main comparison used in the theoretical models of discriminatory effects, e.g., Adams and Yellen [1976]). Cable operator's profits under bundling are 1.7% lower than under “themed tiers”, and 1.5% lower than under mini-tiers by owner. I also compute the full a la carte outcome (unbundling to the level of individual channels), constraining all channel prices to be the same. This provides a lower bound on a la carte profits with channel-specific optimal prices (as discussed earlier, for computational reasons I cannot find optimal channel-specific prices). The profits under full a la carte are also higher than under bundling, even though all channel prices are constrained to be the same. Thus, bundling does not facilitate surplus extraction by the firm relative to unbundled sales. The main reason is that consumers' bundle valuations are still quite heterogeneous. For example, when I look at the distribution of consumers' valuations for the full cable bundle, the 40th percentile of bundle valuations is $39.6 and the 50th percentile is $46.9, 18% higher. This heterogeneity constrains the firm's ability to extract surplus via bundling.

7.5. Discussion

My main finding is that consumers do not gain much from unbundling, even in the best-case scenarios. As discussed earlier, unbundling could benefit consumers in several ways. First, by eliminating the discriminatory effects, it could reduce cable operator's ability to extract surplus from consumers. However, the discriminatory effects of bundling turn out to be non-existent in my

[106] Also, while each “themed tier” combines content from multiple owners, this scenario puts content owners in direct competition with each other, which may amplify their incentives to invest in programming in the long run.

data, so unbundling does not redistribute surplus from the cable operator to consumers. Second, unbundling might increase consumer surplus by partially serving consumers who were not getting cable programming under bundling (local-antenna and basic-only households). Depending on a specific scenario for the programming costs, the share of local-antenna and basic-only households declines by 0.6-8.7 percentage points after unbundling, i.e., a small but non-negligible number of additional consumers are getting served. However, these are the consumers who have relatively low preferences for cable programming, so the welfare gains for them are quite minor. Third, unbundling might reduce the total wholesale cost of cable programming, and consumers might benefit from this cost reduction. In some scenarios, unbundling in fact substantially reduces cable operator's programming costs, however very little of this cost saving is passed on to consumers. Thus, the three effects of unbundling that could potentially benefit consumers in the short run turn out to be small in the data. Also, unbundling might reduce consumer surplus by inefficiently excluding some of the original bundle buyers, for example, occasional sports viewers who value the sports tier at less than its unbundled price. At least for the sports tier, the exclusion of occasional viewers turns out to be quite important. Specifically, in the unbundling outcome for the original license fees, viewership of the sports tier drops by 19% after unbundling, which reduces consumer surplus.

One potentially important assumption in counterfactuals is that satellite does not react to cable unbundling, i.e., it keeps offering its original bundle at the original price (as discussed in section 7.1, counterfactuals with re-optimization by satellite would be much less credible due to data limitations). If satellite reacts to cable unbundling by switching to unbundled sales itself, the gains to consumers *might* be larger[107,108]. Also, cable accounts for almost three quarters of all cable/satellite subscribers in my data (its market share is 57% vs 20% for satellite). Thus, my results indicate that unbundling three quarters of the market would not benefit consumers much even in the best-case scenario.[109]

[107] This is not necessarily the case. For example, Nalebuff (2000) finds that price competition in the "bundle vs bundle" case is more intense than in case of "components vs components" or "bundle vs components".

[108] Alternatively, consumers could gain if satellite reduced the price of its bundle in response to cable unbundling. However, when I compute satellite's best response to the mini-tier prices from column (a) of table 7 (assuming that satellite does not unbundle), the optimal price of the satellite bundle is actually slightly *higher* than it was in the original bundling outcome. In this computation, I treat the two satellite providers as a single firm, and calibrate its marginal costs so that the actual price of the satellite bundle is optimal. (However, as mentioned above, this computation is less credible than my main counterfactuals, due to data limitations for satellite).

[109] In a parallel paper, Crawford and Yurukoglu (2008) find that unbundling substantially benefits consumers. Besides differences in the data (which lead to substantial differences in our estimates of the correlation structure of channel WTPs, as illustrated at the beginning of section 7), several additional factors might account for the difference in our main results. First, they focus on full a la carte (unbundling to the level of individual channels). Second, they compute Nash equilibrium in which all 3 firms (cable and two satellite providers) switch to a la carte. To do that, they have to impose additional assumptions, since the main data limitations for satellite in their case are similar to mine (see section 7.1). Finally, their estimates of viewing preferences do not account for self-selection, due to data limitations. In my estimates, this self-selection turns out to be important, i.e., non-subscribers (local-antenna and basic-only households) have *much* lower unobserved viewing preferences. Thus, if I did not control for self-selection in my data, the model would heavily overpredict unbundled subscriptions, and consequently the welfare gains from unbundling for current non-subscribers. In a follow-up paper, Crawford and Yurukoglu (2009) also find significant welfare gains from unbundling, even after accounting for the increase in upstream prices. However, the

8. Conclusion

Concerns over cable companies' bundling practices and rapid increases in cable prices have sparked an active policy debate about retail unbundling, i.e., requiring cable companies to offer subscriptions to "themed tiers" or individual channels on a la carte basis. Supporters of unbundling policies argue that a switch to unbundled sales would substantially benefit consumers, while opponents argue that it would increase cable prices and destroy the economic foundations of the cable networks.

I develop an empirical model of demand for cable bundles and viewership, and use it to analyze the short-run effects of unbundling policies for consumers, cable operators and cable networks. By tying together consumers' purchases of bundles and their subsequent viewing choices for individual channels, the model allows me to identify consumers' willingness to pay for each channel, and to predict their subscriptions and viewership in out-of-sample unbundling counterfactuals. I estimate the model using individual-level data on cable and satellite subscriptions and viewing choices for 64 main cable channels. I use the estimates to simulate the effects of unbundling policies (primarily "themed tiers"), for several alternative scenarios on how the wholesale prices of cable programming will change after unbundling.

I find that consumers do not gain much from unbundling, even in the best-case scenario. Even if the networks do not increase their wholesale prices (license fees per subscriber) after unbundling, the average short-run increase in the consumer surplus is estimated at just 35 cents per household per month. In this scenario, the networks lose a lot of subscribers, which substantially reduces their revenues from license fees. As a result, the networks are likely to increase their license fees and/or cut their investment in programming. If they increase their license fees to try to offset the loss of subscribers, consumer surplus is estimated to decrease after unbundling.

One scenario that could benefit consumers without hurting the networks is to combine unbundling with a switch to a more efficient arrangement in the upstream market (lump-sum payments or revenue-sharing). In this case, consumer surplus is estimated to increase by $1.63-$1.90 per household per month on average (assuming the best-case scenario that unbundling does not increase cable operators' equipment and customer-service costs). However, a switch to a similar upstream arrangement without unbundling would benefit consumers even more, i.e., the net effect of unbundling itself is negative.

Thus, my results do not support the main argument in favor of unbundling (welfare gains for consumers), but they do support the main concern about unbundling (damage to the cable networks). A potentially more fruitful area for regulatory intervention could be in the upstream market for cable programming, to be explored in future research.

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data limitations in that paper are similar to those in Crawford and Yurukoglu (2008).

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9. Appendix A. Computation and Simulation Details in Estimation

Integrating out the unobservables

In computing all the expectations below, I integrate out the unobserved heterogeneity $w_h \equiv (w_{h,1}, ..., w_{h,K_h}, w_h^p)$ and the unobserved cable system m_h as follows:

$$E(Y|X_h, \theta) = \sum_{m_h} \int_{w_h} E(Y|X_h, w_h, m_h, \theta) dF(w_h|\theta) Pr(m_h|X_h)$$

where Y stands for any dependent variable in the model, and θ denotes the vector of parameters. The distribution of cable systems $\Pr(m_h|X_h)$ was computed in an earlier step (section 5.3), so it does not depend on θ.

I simulate the expectations by drawing R draws of $w_h \sim F(w_h|\theta)$ and $m_h \sim Pr(m_h|X_h)$, and replacing the expectation with the simulation average

$$E(Y|X_h, \theta) \approx \frac{1}{R} \sum_{r=1...R} E(Y|X_h, w_{h,r}, m_{h,r}, \theta)$$

where $w_{h,r}, m_{h,r}$ denote the r'th draw. This simulator is unbiased.

Below, I present the computation of the relevant expectations conditional on a specific draw of w_h, m_h. To reduce the notation, I use $E(...|\bullet)$ as a shorthand for $E(...|X_h, w_h, m_h, \theta)$.

Computing subscription probabilities

I compute predicted probabilities first for the main bundles $Bundle_h$, and then for the premium channels $Prem_{h,j}$.

First, for each household member, I compute viewing utilities for each channel using equation (5.1). Next, I compute her expected viewing utility for each of the available main bundles using equation (5.2). Then, for each household, I compute subscription-stage utility for each main bundle k using equation (5.3).

This gives me the choice probabilities for the main bundles. The provider-specific shocks $\epsilon_{h,f(k)}$ are i.i.d. logit shocks for antenna, cable and satellite. Since the same $\epsilon_{h,f(k)}$ applies to all the cable bundles ($k = 2...4$), and there are no additional unobservables (for a given value of w_h), only one cable bundle will be chosen with positive probability. Specifically,

$$\begin{aligned}
\Pr(Bundle_h &= k|\bullet) = \frac{e^{\overline{V}_{h,k}}}{e^{\overline{V}_{h,1}} + e^{\overline{V}_{h,5}} + \max\{e^{\overline{V}_{h,2}}, e^{\overline{V}_{h,3}}, e^{\overline{V}_{h,4}}\}} \text{ for } k = 1, 5 \\
\Pr(Bundle_h &= k|\bullet) = \frac{e^{\overline{V}_{h,k}} * I\{\overline{V}_{h,k} = \max\{\overline{V}_{h,2}, \overline{V}_{h,3}, \overline{V}_{h,4}\}}{e^{\overline{V}_{h,1}} + e^{\overline{V}_{h,5}} + \max\{e^{\overline{V}_{h,2}}, e^{\overline{V}_{h,3}}, e^{\overline{V}_{h,4}}\}} \text{ for } k = 2, 3, 4
\end{aligned}$$

where $\overline{V}_{h,k} \equiv V_{h,k} - \epsilon_{h,f(k)}$ from equation (5.3). Notice that $\overline{V}_{h,k}$ is a function of X_h, w_h, θ and the characteristics of main bundle k for cable system m_h.[110]

The choice probabilities for the premium channels depend on $Bundle_h$, since local-antenna households cannot get premium channels, and some cable systems do not offer some of the premium channels while satellite offers all of them. I compute the subscription probability for premium channel j as

$$\Pr(Prem_{h,j}|\bullet) = \sum_{k=2...5} \Pr(Prem_{h,j}|\bullet, Bundle_h = k) * \Pr(Bundle_h = k|\bullet)$$

where $\Pr(Prem_{h,j}|\bullet, Bundle_h = k)$ is computed using equation (5.4).

Computing predicted viewing outcomes

The viewing choices depend on household's subscription $Bundle_h, Prem_h$, because it determines which channels consumers can watch at home. Conditional on $Bundle_h$, $Prem_h$ (and X_h, w_h, m_h, θ), individual i's viewing probability for channel j in each period, $\Pr(i, j|\bullet, Bundle_h, Prem_h)$, follows standard multinomial logit, and the viewing utilities are computed using equation (5.1). I use it to compute several types of predicted viewing outcomes.

The first outcome is $E(T_{h,i,j} * I\{Bundle_h = k\}|\bullet)$, computed for each j, k.[111] It is equal to

$$E(T_{h,i,j} * I\{Bundle_h = k\}|\bullet) =$$
$$= \Pr(Bundle_h = k|\bullet) \left(\sum_{Prem_h} E(T_{h,i,j}|\bullet, Bundle_h = k, Prem_h) \Pr(Prem_h|\bullet, Bundle_h = k) \right)$$

where the summation over $Prem_h$ goes over all possible combinations of the premium channels given $Bundle_h$, and

$$E(T_{h,i,j}|\bullet, Bundle_h, Prem_h) = T * \Pr(i, j|\bullet, Bundle_h, Prem_h)$$

where T is the total number of periods.

I also compute the probability of watching channel j at least once over the past week, $E(I\{T_{h,i,j} > 0\} * I\{Bundle_h = k\}|\bullet)$. The computation is similar, the only difference is

$$E(I\{T_{h,i,j} > 0\}|\bullet, Bundle_h, Prem_h) = 1 - (1 - \Pr(i, j|\bullet, Bundle_h, Prem_h))^T$$

[110] In estimation, I compute choice probabilities using an importance sampler that follows Song (2008). Specifically, for each draw of $w_{h,1}, ..., w_{h,K_h}$ and m_h, first I compute the range of w_h^p in which a given cable alternative k yields higher utility than all other cable alternatives (this computation is similar to a standard vertical model). After computing these ranges for each $k = 2...4$, I simulate a fixed number of draws of w_h^p from each range, and compute the choice probability above for each draw of w_h^p. The draws of w_h^p from different ranges are weighted proportionally to the probability of w_h^p being in each range.

[111] An alternative would be to compute $E(T_{h,i,j}|\bullet, Bundle_h = k)$, i.e., viewing time *conditional* on subscription. However, in this case it would be much harder to integrate out the unobservables w_h, m_h, because their distribution conditional on $Bundle_h = k$ is different from the unconditional distribution. Furthermore, the simulation would no longer be unbiased.

For premium channels, I also compute $E(T_{h,i,j} * Prem_{h,j}|\bullet)$, equal to

$$
\begin{aligned}
&E(T_{h,i,j} * Prem_{h,j}|\bullet) = \\
&= \sum_{Bundle_h=1...5} E(T_{h,i,j}|\bullet, Bundle_h, Prem_{h,j}=1)\Pr(Prem_{h,j}=1|\bullet, Bundle_h)\Pr(Bundle_h|\bullet)
\end{aligned}
$$

The second outcome is $E(T_{h,i,j_1} * T_{h,i,j_2}|\bullet)$, computed for each j_1, j_2 $(j_1 \neq j_2)$. It is equal to

$$
\begin{aligned}
&E(T_{h,i,j_1} * T_{h,i,j_2}|\bullet) = \\
&= \sum_{Bundle_h, Prem_h} E(T_{h,i,j_1} * T_{h,i,j_2}|\bullet, Bundle_h, Prem_h)\Pr(Prem_h|\bullet, Bundle_h)\Pr(Bundle_h=k|\bullet)
\end{aligned}
$$

where the summation is for $Bundle_h = 1...5$ and for all possible values of $Prem_h$ given $Bundle_h$. $E(T_{h,i,j1} * T_{h,i,j2}|\bullet, Bundle_h, Prem_h)$ can be computed fast as

$$
E(T_{h,i,j_1}*T_{h,i,j_2}|\bullet, Bundle_h, Prem_h) = T(T-1)\Pr(i, j_1|\bullet, Bundle_h, Prem_h)\Pr(i, j_2|\bullet, Bundle_h, Prem_h)
$$

(the multiplier is $T(T-1)$ not T^2 because only one channel can be chosen at any given t).

The third outcome is $E(T_{h,i_1} * T_{h,i_2}|\bullet)$, where $T_{h,i} \equiv \sum_{j=1...J} T_{h,i,j}$ denotes total viewing time for household member i. $Bundle_h$ and $Prem_h$ are integrated out in the same way as for $E(T_{h,i,j_1} * T_{h,i,j_2}|\bullet)$, and $E(T_{h,i_1} * T_{h,i_2}|\bullet, Bundle_h, Prem_h)$ is computed as

$$
E(T_{h,i_1} * T_{h,i_2}|\bullet, Bundle_h, Prem_h) = T^2\Pr(i_1|\bullet, Bundle_h, Prem_h)\Pr(i_2|\bullet, Bundle_h, Prem_h)
$$

where $\Pr(i|\bullet, Bundle_h, Prem_h) \equiv \sum_{j=1...J}\Pr(i, j|\bullet, Bundle_h, Prem_h)$ is the per-period probability of watching any of the J cable channels.

Direct computation of the viewing-time outcomes would require summation over all possible combinations of $Bundle_h$ and $Prem_h$, which is hundreds of combinations. To reduce the computational burden to a reasonable level, I use simulation instead. Specifically, for each draw of w_h, m_h, I generate one draw of $Bundle_h, Prem_h$ based on the probabilities $\Pr(Bundle_h = k|\bullet)$, $\Pr(Prem_{h,j}|\bullet, Bundle_h = k)$, and replace the summation (which corresponds to taking expectation) with an unbiased simulation based on this draw.[112]

[112] A direct frequency simulator would not be differentiable, therefore I use a simple importance sampler to smooth it out (i.e., I keep the draws of $Bundle_h$, $Prem_h$ fixed and adjust the weights on these draws).

Appendix B.

Table 1. Subscriptions

	4 DMAs*	national**
antenna	23%	16%
basic-only	7%***	8%
expanded basic	24%***	34%
digital cable	26%	23%
satellite	20%	19%

* Simmons data. The 4 DMAs are Boston (MA only), Los Angeles, New York (NY only) and San Francisco.
** Data from FCC (2005a).
*** Simmons does not distinguish between basic-only and expanded-basic subscriptions (both are pooled into "analog cable"). The break-down between basic and expanded basic uses the national proportion of basic-only subscribers, from FCC (2005a).

Table 2. Viewership among cable/satellite subscribers, channel availability on cable

	channel genre*	Viewership among cable/satellite subscribers			channel availability		break-down of analog**	
		% watched	avg time	avg non-zero time	analog	digital	basic	exp. basic
A&E	general entertainment	19%	0.49	2.5	96%	0%	7%	89%
ABC Family	family	12%	0.30	2.5	100%	0%	5%	95%
AMC	movies	11%	0.30	2.7	96%	0%	4%	92%
Animal Planet	education/learning	17%	0.36	2.1	73%	17%	2%	72%
BBC America	general entertainment	5%	0.10	2.2	0%	72%	–	–
BET	general entertainment	7%	0.28	3.9	90%	0%	3%	89%
Bravo	general entertainment	11%	0.25	2.3	84%	10%	4%	80%
Cartoon Network	family	11%	0.34	3.0	93%	0%	0%	94%
Cinemax (premium)	movies	8%	0.25	3.1	–	–	–	–
CMT	general entertainment	4%	0.07	1.9	40%	31%	0%	41%
CNBC	news/information	13%	0.31	2.4	99%	0%	8%	92%
CNN	news/information	24%	0.56	2.3	100%	0%	5%	95%
CNN Headlines	news/information	13%	0.28	2.2	90%	0%	3%	88%
Comedy Central	general entertainment	18%	0.48	2.6	96%	0%	6%	91%
Court TV	general entertainment	9%	0.22	2.5	85%	2%	3%	82%
Discovery	education/learning	28%	0.72	2.6	98%	0%	24%	73%
Discovery Health	education/learning	5%	0.12	2.4	0%	9%	–	–
Disney	family	9%	0.25	2.9	83%	11%	1%	84%
E!	general entertainment	15%	0.31	2.0	96%	0%	6%	90%
Encore (premium)	movies	4%	0.10	2.6	–	–	–	–
ESPN	sports	20%	0.62	3.1	100%	0%	10%	90%
ESPN2	sports	13%	0.36	2.9	91%	1%	2%	89%
ESPN Classic	sports	4%	0.07	1.9	24%	62%	0%	23%
ESPN News	sports	7%	0.17	2.4	0%	73%	–	–
Food Network	education/learning	19%	0.58	3.1	86%	7%	23%	63%
FOX News	news/information	20%	0.60	3.0	91%	0%	5%	88%
FOX Sports	sports	14%	0.43	3.0	87%	8%	5%	84%
Fuse	general entertainment	1%	0.02	2.3	10%	48%	0%	10%
FX	general entertainment	13%	0.32	2.5	86%	0%	3%	83%
GSN	general entertainment	4%	0.12	2.8	23%	58%	1%	17%
Hallmark	family	3%	0.08	2.5	49%	17%	4%	46%
HBO (premium)	movies	26%	0.96	3.7	–	–	–	–
History Channel	education/learning	20%	0.55	2.7	91%	4%	3%	90%
HGTV	education/learning	13%	0.41	3.2	62%	26%	1%	59%
IFC	movies	4%	0.12	2.7	5%	70%	0%	6%
Lifetime	women's programming	20%	0.70	3.5	100%	0%	8%	92%
TMC (premium)	movies	8%	0.22	2.7	–	–	–	–
MSNBC	news/information	17%	0.41	2.5	92%	0%	9%	84%
MTV	general entertainment	20%	0.50	2.6	100%	0%	8%	92%
Nat'l Geographic	education/learning	9%	0.21	2.4	12%	45%	4%	10%
Nick @ nite***	family	9%	0.21	2.3	100%	0%	7%	93%
Nickelodeon***	family	8%	0.22	2.7	100%	0%	7%	93%
Outdoor Channel	sports	2%	0.04	2.2	0%	35%	–	–

	channel genre*	Viewership among cable/satellite subscribers			channel availability		break-down of analog**	
		% watched	avg time	avg non-zero time	analog	digital	basic	exp. basic
Oxygen	women's programming	7%	0.15	2.2	37%	26%	0%	40%
Sci-Fi	general entertainment	12%	0.35	3.0	81%	15%	0%	81%
Showtime (premium)	movies	11%	0.33	2.9	–	–	–	–
Soapnet	women's programming	2%	0.08	3.7	8%	27%	0%	8%
Speed	sports	4%	0.12	3.3	26%	48%	0%	24%
Spike	general entertainment	12%	0.30	2.6	97%	0%	3%	95%
StarZ (premium)	movies	10%	0.33	3.3	–	–	–	–
Style	general entertainment	2%	0.05	2.5	11%	54%	0%	12%
TBS	general entertainment	24%	0.64	2.7	98%	0%	45%	53%
TLC	education/learning	19%	0.58	3.1	98%	0%	7%	92%
TNT	general entertainment	24%	0.64	2.7	100%	0%	5%	95%
Toon Disney	family	5%	0.11	2.4	3%	70%	0%	4%
Travel Channel	education/learning	11%	0.25	2.3	66%	17%	3%	60%
TCM	movies	7%	0.21	3.1	21%	54%	1%	19%
TV Guide	general entertainment	6%	0.06	1.0	74%	0%	60%	14%
TV Land	family	8%	0.21	2.5	66%	28%	1%	63%
USA	general entertainment	21%	0.55	2.6	100%	0%	7%	93%
VH1	general entertainment	12%	0.25	2.2	99%	0%	7%	92%
WE	women's programming	6%	0.14	2.6	43%	39%	0%	39%
Weather Channel	news/information	19%	0.21	1.1	95%	0%	10%	85%
WGN	general entertainment	4%	0.09	2.3	19%	0%	15%	5%

Viewing data: Simmons, 4 DMAs.
Channel availability data: Television and Cable Factbook 2005, 4 DMAs, cable systems weighted by system size.
Premium channels are always offered separately from the main tiers.
* the channel genres are from DISH Network's site, www.dishnetwork.com, with minor modifications.
** only for cable systems offering separate basic and expanded-basic packages (90.7% of all systems, weighted by system size).
*** Nickelodeon and Nick @ Nite are reported separately in the data, so I treat them as if they are two separate channels.

Table 3. Correlation of viewing time for selected channels (cable/satellite subscribers only)

	Cartoon Network	CNN	Discovery	ESPN	HBO	Lifetime	MTV	TBS
A&E	-0.01	0.15	0.15	0.03	0.01	0.10	-0.04	0.10
ABC Family	0.07	0.06	0.09	0.01	0.01	0.13	0.05	0.10
Animal Planet	0.10	0.06	0.24	0.03	0.01	0.07	0.01	0.04
BET	0.06	0.01	0.01	0.04	0.07	0.09	0.22	0.05
Cartoon Network	-	-0.02	0.07	0.00	0.08	0.01	0.07	0.04
CNN	-0.02	-	0.12	0.11	0.05	0.04	-0.03	0.02
CNN Headlines	-0.01	0.35	0.11	0.04	0.02	0.04	-0.02	-0.01
Comedy Central	0.10	0.04	0.09	0.06	0.07	0.02	0.19	0.09
Discovery	0.07	0.12	-	0.06	0.06	0.03	0.02	0.07
E!	0.03	0.06	0.10	0.05	0.08	0.10	0.22	0.07
ESPN	0.00	0.11	0.06	-	0.12	-0.03	0.05	0.11
ESPN2	0.03	0.08	0.06	0.67	0.13	-0.02	0.06	0.15
Food Network	-0.01	0.06	0.14	0.05	0.02	0.07	0.05	0.04
FOX News	-0.02	0.19	0.11	0.08	0.03	0.03	-0.03	0.00
FOX Sports	-0.01	0.11	0.05	0.36	0.08	-0.01	0.02	0.07
HBO	0.08	0.05	0.06	0.12	-	0.08	0.11	0.07
History Channel	0.00	0.14	0.30	0.06	0.11	0.04	-0.03	0.07
HGTV	-0.03	0.05	0.13	-0.02	0.03	0.07	-0.01	0.01
Lifetime	0.01	0.04	0.03	-0.03	0.08	-	0.05	0.16
MTV	0.07	-0.03	0.02	0.05	0.11	0.05	-	0.09
Nickelodeon	0.24	-0.04	0.03	-0.01	0.03	0.02	0.08	0.05
Showtime	0.05	0.01	0.05	0.04	0.32	0.02	0.06	0.07
TBS	0.04	0.02	0.07	0.11	0.07	0.16	0.09	-
TLC	0.02	0.03	0.21	0.01	0.04	0.08	0.09	0.15
TNT	0.01	0.07	0.05	0.08	0.08	0.11	0.03	0.31
USA	-0.01	0.03	0.03	0.06	0.06	0.14	0.03	0.27
VH1	0.02	0.02	0.03	0.04	0.10	0.05	0.34	0.10

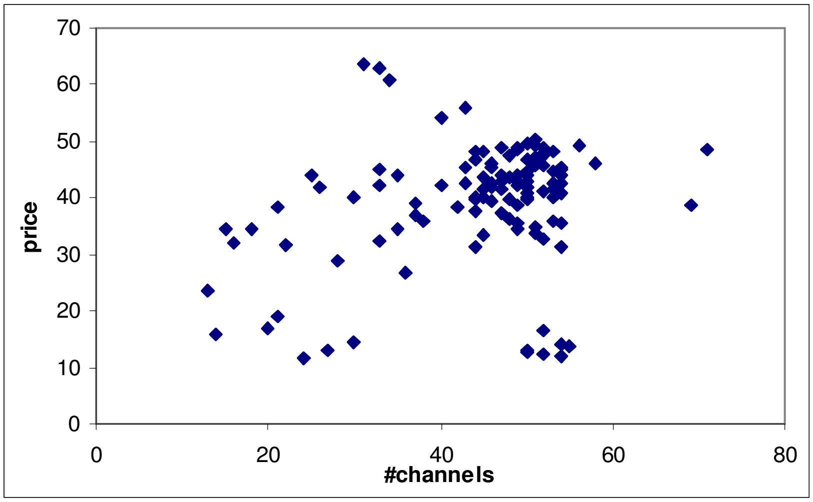


Figure 1. Variation across cable systems in price and number of channels for the most popular combination of packages (basic plus expanded-basic)

Table 4. The estimates
(a) η_j, η_j^f

channel	η_j		η_j^f		channel	η_j		η_j^f	
	est.	s.e.	est.	s.e.		est.	s.e.	est.	s.e.
A&E	-3.63	0.19	-3.00	0.09	History Channel	-3.74	0.20	-2.64	0.08
ABC Family	-2.41	0.12	-2.66	0.10	HGTV	-3.24	0.19	-2.40	0.09
AMC	-4.11	0.30	-2.95	0.11	IFC	-4.03	0.32	-2.44	0.19
Animal Planet	-4.64	0.27	-3.52	0.13	Lifetime	-8.60	1.65	-4.26	0.63
BBC America	-3.77	0.25	-2.81	0.20	TMC	-3.52	0.26	-2.48	0.13
BET	-4.78	0.37	-2.91	0.17	MSNBC	-3.05	0.23	-2.60	0.12
Bravo	-3.39	0.17	-2.70	0.09	MTV	-3.62	0.19	-2.70	0.09
Cartoon Network	-2.90	0.15	-2.59	0.08	Nat'l Geographic	-3.77	0.20	-2.83	0.12
Cinemax	-3.82	0.26	-2.49	0.13	Nick @ nite	-2.30	0.13	-2.41	0.11
CMT	-3.27	0.26	-2.61	0.20	Nickelodeon	-3.10	0.17	-2.52	0.10
CNBC	-3.16	0.23	-2.57	0.11	Outdoor Channel	-6.26	0.82	-3.74	0.58
CNN	-3.47	0.20	-3.05	0.10	Oxygen	-9.74	1.78	-3.98	0.49
CNN Headlines	-3.46	0.25	-2.85	0.13	Sci-Fi	-3.08	0.17	-2.40	0.10
Comedy Central	-3.82	0.18	-2.99	0.10	Showtime	-3.66	0.26	-2.45	0.13
Court TV	-3.29	0.21	-2.62	0.13	Soapnet	-10.13	1.89	-3.87	0.53
Discovery	-3.82	0.18	-2.89	0.07	Speed	-4.92	0.64	-2.70	0.21
Discovery Health	-4.25	0.27	-3.00	0.20	Spike	-3.91	0.21	-2.86	0.12
Disney	-2.80	0.15	-2.47	0.08	StarZ	-3.50	0.28	-2.32	0.13
E!	-4.25	0.22	-3.26	0.10	Style	-3.60	0.27	-2.54	0.20
Encore	-3.60	0.30	-2.32	0.17	TBS	-3.40	0.17	-2.83	0.08
ESPN	-4.61	0.60	-2.60	0.12	TLC	-3.48	0.18	-2.51	0.07
ESPN2	-4.67	0.61	-2.59	0.12	TNT	-3.16	0.14	-2.74	0.07
ESPN Classic	-5.53	0.59	-3.32	0.25	Toon Disney	-3.19	0.16	-2.49	0.11
ESPN News	-4.97	0.61	-2.86	0.16	Travel Channel	-3.68	0.19	-2.76	0.09
Food Network	-4.01	0.21	-3.00	0.11	TCM	-3.43	0.27	-2.43	0.13
FOX News	-2.97	0.21	-2.56	0.10	TV Guide	-3.71	0.22	-3.22	0.17
FOX Sports	-4.79	0.62	-2.97	0.15	TV Land	-2.26	0.16	-2.35	0.12
Fuse	-4.15	0.47	-2.52	0.43	USA	-3.01	0.14	-2.62	0.07
FX	-3.57	0.18	-2.83	0.10	VH1	-3.85	0.21	-2.87	0.12
GSN	-2.85	0.23	-2.27	0.19	WE	-9.53	1.71	-3.92	0.40
Hallmark	-2.41	0.17	-2.60	0.17	Weather Channel	-4.14	0.21	-3.92	0.14
HBO	-3.28	0.25	-2.25	0.10	WGN	-3.05	0.24	-2.51	0.18

(b) preferences for channel genre – demographics

	gen. entertainment		education / learning		sports		movies		family		news / information		women's programming	
	est.	s.e.	est.	s.e.	est.	s.e.	est.	s.e.	est.	s.e.	est.	s.e.	est.	s.e.
male*	-0.84	0.09	-0.86	0.10	-1.02	0.15	-0.82	0.09	-0.72	0.08	-0.86	0.09	-1.51	0.30
age*	2.65	0.60	2.92	0.64	5.04	1.55	0.87	0.66	-2.52	0.58	3.20	0.88	25.25	7.80
hispanic	-0.12	0.03	-0.05	0.03	0.02	0.05	0.03	0.04	-0.21	0.04	-0.15	0.04	-0.68	0.34
black*	-0.41	0.10	-0.23	0.07	-0.25	0.13	-0.41	0.12	-0.46	0.10	-0.27	0.08	0.32	0.42
dropout	-0.06	0.03	-0.09	0.03	0.05	0.06	-0.02	0.03	-0.10	0.03	-0.10	0.03	-0.19	0.28
college+*	-1.32	0.16	-1.54	0.18	-1.75	0.21	-1.46	0.17	-1.18	0.14	-1.64	0.19	-1.26	0.26
student	0.15	0.05	0.05	0.04	0.17	0.08	-0.02	0.06	-0.07	0.04	0.08	0.05	0.77	0.40
employed	0.01	0.02	-0.02	0.03	-0.09	0.06	-0.10	0.04	-0.05	0.02	0.01	0.03	0.11	0.23
children in hh*	-1.39	0.13	-1.34	0.13	-1.24	0.13	-1.55	0.15	-1.83	0.17	-1.20	0.12	-1.13	0.31
hh income	0.95	0.45	3.94	0.72	7.35	2.08	4.80	1.03	-0.80	0.45	0.32	0.50	12.57	5.42

* notice that demographics also enter channel preferences via the demographic-match parameters in (c) below.

(c) other parameters in channel preferences (except for UH parameters)

ψ-s			demographic match*			miscellaneous		
	est.	s.e.		est.	s.e.		est.	s.e.
const	-0.28	0.19	male*%male	1.73	0.19	Δratings**	1.23	0.22
ratings	2.09	0.72	(age – avg age)^2	-0.09	0.07	κ_0***	10.00	–
education/learning	-0.26	0.17	black*%black	2.66	0.46	κ_1***	40.00	–
sports	-0.35	0.19	college*%college	5.64	0.67	$\eta_{otherDBS}$	0.31	0.05
movies	-0.01	0.21	children*%children	3.71	0.35	η_{other}	-6.93	0.91
family	0.18	0.17				ρ	0.07	0.04
news/information	0.14	0.24						
women	0.00	0.36						

* demographic match: respondent's demographics vs average audience demographics for channel j.
** Δratings = DMA rating – national rating for channel j (proxies for local preferences).
*** the κ-s kept going to infinity (leading to overflow), therefore I fixed them at reasonably high values.

(d) unobserved heterogeneity in genre preferences

(instead of directly estimating Ω, I estimate a triangular matrix of coefficients on u~N(0,I_{7*7}))

	u1		u2		u3		u4		u5		u6		u7	
	est	s.e.	est	s.e.	est	s.e.	est	s.e.	est	s.e.	est	s.e.	est	s.e.
gen. entertainment	-0.26	0.03	-0.14	0.02	-0.10	0.04	-0.22	0.03	-0.15	0.03	-0.07	0.02	-0.70	0.18
education/learning			-0.21	0.03	0.08	0.03	0.01	0.02	-0.09	0.02	-0.11	0.03	0.04	0.15
sports					-0.31	0.08	-0.09	0.03	-0.10	0.03	-0.16	0.04	0.68	0.20
movies							-0.25	0.04	-0.09	0.03	-0.05	0.03	-0.41	0.21
family									0.17	0.03	-0.05	0.03	0.77	0.28
news/information											0.11	0.04	1.10	0.37
women													-0.42	0.47

(e) factor-analytic parameters Π_j

(estimated only for the top-32 channels, 3 dimensions. I do not impose a rotation normalization because the parameters are pinned down anyway for a finite number of simulation draws)

channel	dimension 1		dimension 2		dimension 3	
	est.	s.e.	est.	s.e.	est.	s.e.
A&E	0.06	0.04	-0.48	0.07	0.09	0.05
ABC Family	-0.16	0.04	-0.19	0.04	0.05	0.03
AMC	-0.11	0.07	-0.54	0.10	-0.03	0.07
Animal Planet	-0.12	0.06	-0.55	0.11	0.25	0.07
BET	-0.44	0.12	-0.17	0.08	0.35	0.09
Cartoon Network	-0.05	0.02	-0.11	0.03	0.07	0.02
CNN	-0.01	0.03	-0.21	0.05	-0.05	0.03
CNN Headlines	0.05	0.03	-0.17	0.04	-0.10	0.04
Comedy Central	-0.15	0.04	-0.15	0.04	0.21	0.04
Court TV	0.12	0.04	-0.30	0.05	0.09	0.04
Discovery	0.01	0.03	-0.26	0.04	0.12	0.03
E!	-0.21	0.07	-0.27	0.06	0.30	0.06
ESPN	-0.24	0.07	-0.13	0.04	0.04	0.03
ESPN2	-0.25	0.07	-0.11	0.04	-0.01	0.04
Food Network	-0.18	0.05	-0.20	0.04	0.24	0.05
FOX News	0.02	0.03	-0.10	0.03	0.16	0.04
FOX Sports	-0.13	0.05	-0.23	0.07	0.15	0.05

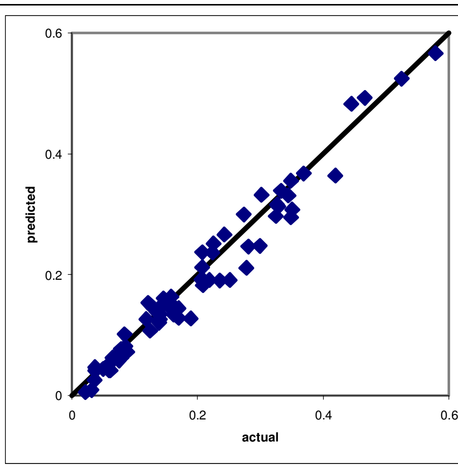
channel	dimension 1		dimension 2		dimension 3	
	est.	s.e.	est.	s.e.	est.	s.e.
FX	-0.09	0.03	-0.21	0.04	0.07	0.03
HBO	-0.05	0.02	-0.04	0.02	0.07	0.02
History Channel	0.01	0.03	-0.18	0.03	0.09	0.03
HGTV	-0.02	0.02	-0.06	0.02	0.10	0.03
Lifetime	-0.44	0.17	-0.85	0.20	0.15	0.15
MTV	-0.24	0.05	0.00	0.04	0.22	0.05
Sci-Fi	0.03	0.03	-0.10	0.02	-0.02	0.02
Showtime	0.00	0.03	-0.14	0.03	0.00	0.03
Spike	-0.21	0.04	-0.25	0.05	0.04	0.04
TBS	-0.28	0.06	-0.25	0.05	-0.14	0.04
TLC	-0.08	0.03	-0.11	0.02	-0.01	0.02
TNT	-0.15	0.03	-0.18	0.03	-0.04	0.03
USA	-0.08	0.02	-0.08	0.02	-0.04	0.02
VH1	-0.24	0.05	-0.04	0.03	0.14	0.04
Weather Channel	-0.10	0.04	-0.14	0.04	-0.02	0.03

(f) bundle choice parameters

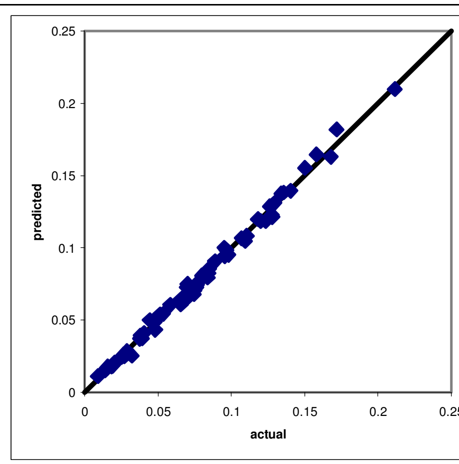
main bundle choice			coefficients on price residuals			premium subscriptions		
	est.	s.e.		est.	s.e.		est.	s.e.
ξ_{basic}	0.34	1.82	in ξ_{basic}			$\eta_{cinemax}$	5.83	1.89
$\xi_{exp.basic}$	3.75	4.02	γ_{basic}	1.62	0.52	η_{encore}	6.43	2.02
$\xi_{digital}$	2.18	5.41	$\gamma_{exp.basic}$	-0.51	0.31	η_{hbo}	5.41	1.68
ξ_{DBS}	-11.84	5.20	$\gamma_{digital}$	0.34	0.60	η_{tmc}	5.90	1.90
φ_0	49.8	8.4	in $\xi_{exp.basic}$			$\eta_{showtime}$	5.56	1.82
φ_1	2.73	0.85	γ_{basic}	0.81	0.29	η_{starz}	5.62	1.87
α_0	-0.37	0.11	$\gamma_{exp.basic}$	0.11	0.14	$\varphi_{prem,0}$	0.56	0.12
α_{income}	0.011	0.002	$\gamma_{digital}$	-1.10	0.52	$\varphi_{prem,1}$	0.03	0.02
α_w*	0.10	–	in $\xi_{digital}$			$\alpha_{prem,income}$	-0.01	0.41
σ_{logit}*	0.22	0.54	γ_{basic}	1.20	0.32			
λ_{house}	2.53	0.81	$\gamma_{exp.basic}$	0.39	0.19			
$\lambda_{ownHouse}$	-1.72	0.71	$\gamma_{digital}$	-1.81	0.80			
λ_{NY}	-0.89	0.86						
λ_{LA}	-1.62	0.84						
λ_{SF}	-0.23	0.76						

* I normalize the variance of w_h^p and instead estimate the variance of the logit shocks.

I use 20 simulation draws in estimation. The standard errors above do not account for the simulation variance and variance of the first-stage parameters (distribution of locations for each household and price residuals). The sample is stratified by the X-s, so I do not use sample weights in estimation (Wooldridge [2001] shows that unweighted estimators are more efficient in this case).

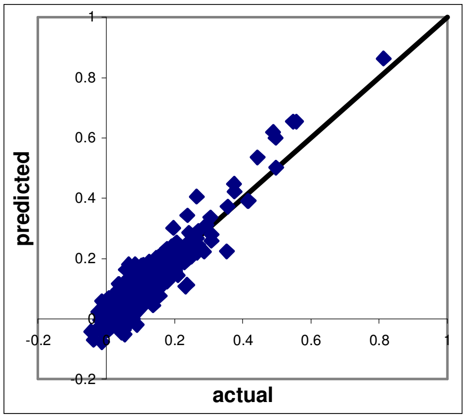


mean time

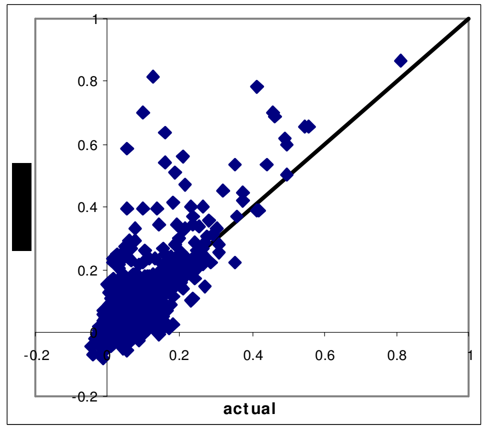


proportion of non-zero time

Figure 2. Predicted and actual mean time and % non-zero time for each channel

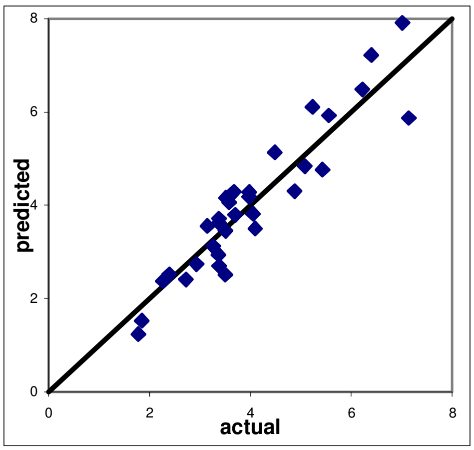


all pairs of the top-32 channels

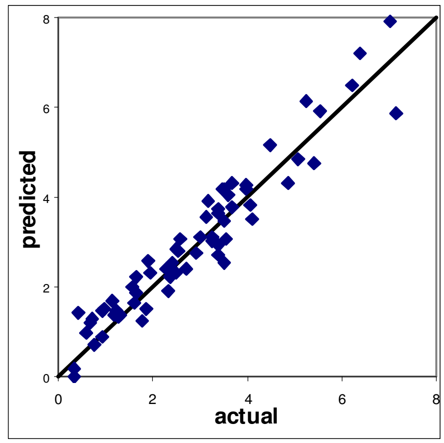


all pairs of the 64 channels

Figure 3. Predicted and actual covariances of viewing time for each pair of channels



top-32 channels



all channels

Figure 4. Predicted and actual covariances of viewing time between each channel and the rest of channels combined

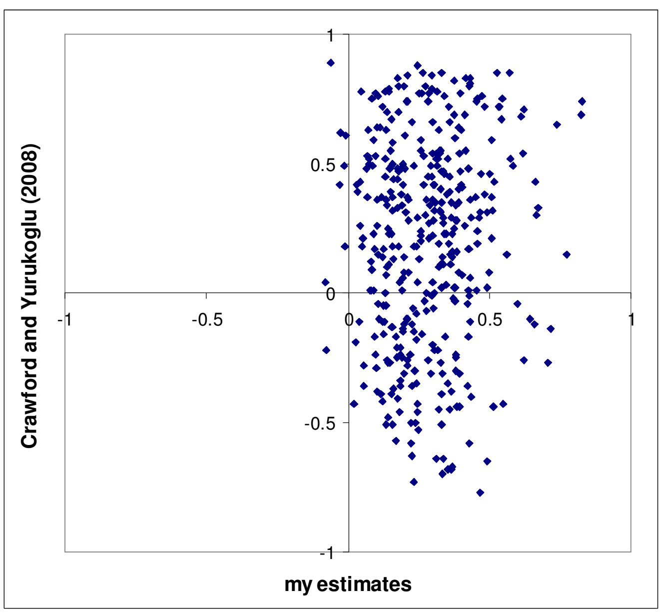


Figure 5. Comparison of cor(WTP) in my estimates and in Crawford and Yurukoglu (2008)

Table 5a. Descriptive statistics for the "themed tiers"

	general entertainment	education / learning	sports	movies (non-premium)	family	news / information	women's programming
average time*	6.0	3.7	1.8	0.6	1.7	2.4	1.0
% of total**	35%	21%	10%	4%	10%	14%	6%
license fees	3.81	1.1	4.33	0.63	1.63	1.13	0.34
% of total**	29%	8%	33%	5%	13%	9%	3%
#channels	20	8	6	3	8	6	3
list of channels	A&E, BBC America, BET, Bravo, CMT, Comedy Central, Court TV, E!, Fuse, FX, GSN, MTV, SCI-FI, Spike TV, Style, TBS, TNT, TV Guide, USA, VH1	Animal Planet, Discovery, Food Network, HGTV, History Channel, National Geographic, TLC, Travel Channel	ESPN, ESPN Classic, ESPN News, ESPN2, FOX Sports, Speed Channel	AMC, IFC, TCM	ABC Family, Cartoon Network, Disney, Hallmark, Nickelodeon/ Nick at Night, Toon Disney, TV Land	CNBC, CNN, CNN Headlines, FOX News, MSNBC, Weather Channel	Lifetime, Oxygen, WE

* hours per week per person, among cable/satellite subscribers
** % of the total among the 54 cable channels in the "representative bundle"

Table 5b. Descriptive statistics for the mini-tiers by owner

	Disney	Time Warner	Fox	NBC Universal	Viacom	other
average time*	3.6	2.9	1.7	1.9	2.6	4.4
% of total**	21%	17%	10%	11%	15%	26%
license fees	4.41	2.02	2.26	1.11	1.35	1.82
% of total**	34%	16%	17%	9%	10%	14%
# channels	10	7	6	5	10	16
list of channels	A&E, ABC Family, Disney, ESPN, ESPN Classic, ESPN News, ESPN2, History Channel, Lifetime, Toon Disney	Cartoon Network, CNN, CNN Headlines, Court TV, TBS, TCM, TNT	FOX News, FOX Sports, FX, National Geographic, Speed Channel, TV Guide	Bravo, CNBC, MSNBC, Sci-Fi, USA	BBC America, BET, CMT, Comedy Central, MTV, Nickelodeon/ Nick at Night, Spike TV, TV Land, VH1	AMC, Animal Planet, Discovery, E!, Food Network, Fuse, GSN, Hallmark, HGTV, IFC, Oxygen, Style, TLC, Travel Channel, WE, Weather Channel

* hours per week per person, among cable/satellite subscribers
** % of the total among the 54 cable channels in the "representative bundle"

Table 6. Bundling outcomes for various cost scenarios

	(a) original license fees	(b) P_{basic}=15, orig. lic. fees	(c) lump-sum license fees	(d) revenue-sharing
prices				
basic	23.13	15.00	28.66	29.02
full bundle	46.64	46.46	42.30	42.13
market shares				
antenna	24.4%	19.6%	25.0%	25.0%
satellite	21.3%	20.6%	17.0%	16.8%
basic only	7.0%	13.6%	4.2%	4.1%
full bundle	47.3%	46.3%	53.8%	54.1%
profits (w/o subtracting fixed costs), $ per household in population				
cable operator	18.80	18.61	19.27	19.20
networks	17.8	17.50	17.46	17.52
satellite	5.46	5.29	4.31	4.27
welfare change relative to (a), $ per household in population				
Δ consumer surplus	–	0.89	1.89	1.97
Δ total welfare	–	0.23	0.86	0.89

I assume that satellite does not react to changes in cable prices (in all cases, it keeps offering DirecTV Total Choice with locals at $40), and the license-fees arrangement for satellite does not change.
Cable operator's marginal costs are $3/sub (franchise fees plus fees to broadcast networks) plus license fees to the cable networks. Besides subscription fees, cable operator gets revenues from its share of advertising time (which it takes into account when computing optimal prices).
Networks' revenues are from advertising and license fees, the marginal costs per subscriber are zero.
For satellite, I assume additional equipment costs of $5/sub per month (satellite dish+receiver).
In computing profits, I do not subtract fixed costs, which are likely to be substantial for all the industry participants.

Table 7a. "Themed tiers" for various cost scenarios

	(a) original license fees	(b) P_{basic}=15, orig. fees	(c) lump-sum license fees	(d) revenue-sharing	(e) proportional increase
welfare change relative to original bundling (column (a) in table 6)					
Δ consumer surplus	0.35	1.62	1.63	1.90	-2.43
Δ total welfare	0.02	-0.33	0.85	0.97	-2.56
welfare change relative to parallel bundling (same column in table 6)					
Δ consumer surplus	0.35	0.73	-0.26	-0.07	–
Δ total welfare	0.02	-0.56	-0.01	0.08	–
prices					
basic	29.01	15.00	31.17	30.12	27.89
general entertainment	6.97	12.46	4.91	4.97	7.85
education/learning	2.04	6.58	2.33	3.47	1.17
sports	9.27	11.67	3.44	3.50	37.01
movies (non-premium)	3.47	3.85	2.91	2.37	9.38
family	2.81	8.06	0.97	0.94	3.82
news/information	3.38	7.65	3.04	3.37	3.20
women's programming	0.20	1.51	0.56	0.01	0.05
market shares					
antenna	23.7%	16.1%	24.0%	23.6%	23.4%
satellite*	18.9%	18.2%	16.6%	16.3%	22.1%
basic	3.1%	8.4%	2.7%	2.7%	3.4%
basic+tiers	54.3%	57.4%	56.7%	57.4%	51.1%
tier subscriptions as % of all cable subscribers					
general entertainment	70%	55%	74%	74%	68%
education/learning	66%	51%	66%	64%	67%
sports	27%	21%	36%	36%	11%
movies (non-premium)	26%	22%	28%	29%	15%
family	55%	40%	60%	60%	52%
news/information	60%	44%	62%	60%	60%
women's programming	43%	33%	42%	47%	43%
avg # tiers/sub	3.5	2.7	3.7	3.7	3.2
profits ($ per household in population)					
cable operator	21.75	20.93	19.61	19.41	20.13
cable networks	15.06	14.36	17.39	17.54	15.95
satellite*	4.92	4.82	4.28	4.19	5.85

* notice that satellite is assumed to not react to cable unbundling, for reasons discussed in section 7.1.

Table 7b. "Themed tiers" – outcomes for the networks
(% change relative to original bundling, column (a) of table 6)

	(a) original license fees	(b) P_{basic}=15, orig. fees	(c) lump-sum license fees	(d) revenue-sharing	(e) proportional increase
% change in viewership					
among cable subs	1%	-4%	8%	9%	-11%
total cable+satellite	0%	-2%	2%	2%	-4%
% change in the number of subscribers					
among cable subs	-40%	-47%	-34%	-33%	-48%
total cable+satellite	-31%	-37%	-30%	-30%	-32%
% change in license-fee revenues					
among cable subs	-40%	-47%	0%	3%	-27%
total cable+satellite	-31%	-37%	-7%	-5%	-17%
% change in total revenues (advertising + license fees)					
among cable subs	-18%	-24%	4%	6%	-19%
total cable+satellite	-15%	-19%	-2%	-1%	-10%
% change in viewership (among cable subs), by tier					
general entertainment	1%	-5%	8%	9%	-7%
education/learning	3%	-1%	8%	7%	-4%
sports	-19%	-24%	2%	2%	-67%
movies (non-premium)	-12%	-13%	-4%	0%	-46%
family	10%	4%	17%	18%	3%
news/information	3%	-4%	8%	8%	-5%
women's programming	5%	4%	9%	11%	-1%
% change in license-fee revenues (among cable subs), by tier					
general entertainment	-15%	-24%	0%	3%	-8%
education/learning	-20%	-29%	0%	3%	-4%
sports	-68%	-70%	0%	3%	-60%
movies (non-premium)	-69%	-69%	0%	3%	-45%
family	-33%	-45%	0%	3%	-9%
news/information	-27%	-38%	0%	3%	-6%
women's programming	-48%	-54%	0%	3%	-5%

Table 8a. Mini-tiers by owner for various cost scenarios

	(a) original license fees	(b) P_{basic}=15, orig. fees	(c) lump-sum license fees	(d) revenue-sharing	(e) proportional increase
welfare change relative to original bundling (column (a) in table 6)					
Δ consumer surplus	0.31	1.22	1.99	2.04	-0.78
Δ total welfare	-0.03	-0.08	1.09	1.10	-0.94
welfare change relative to parallel bundling (same column in table 6)					
Δ consumer surplus	0.31	0.34	0.10	0.08	–
Δ total welfare	-0.03	-0.30	0.22	0.21	–
prices					
basic	23.48	15.00	28.37	29.00	23.00
Disney	9.28	11.11	4.43	3.85	10.77
Time Warner	4.09	5.98	3.28	3.06	3.34
Fox	6.23	6.42	2.79	2.84	11.38
NBC Universal	3.29	4.76	3.32	3.11	3.22
Viacom	2.26	4.97	0.70	0.75	2.75
other	3.36	6.44	2.37	2.33	3.04
market shares					
antenna	21.9%	16.5%	23.4%	23.6%	21.6%
satellite*	19.5%	18.8%	16.4%	16.3%	20.9%
basic	4.5%	8.3%	3.0%	2.9%	4.6%
basic+tiers	54.1%	56.4%	57.2%	57.2%	52.8%
tier subscriptions as % of all cable subscribers					
Disney	65%	55%	78%	80%	60%
Time Warner	72%	63%	76%	77%	74%
Fox	46%	42%	61%	61%	31%
NBC Universal	60%	52%	61%	62%	60%
Viacom	64%	53%	71%	70%	62%
other	75%	63%	80%	80%	75%
avg # tiers/sub	3.8	3.3	4.3	4.3	3.6
profits ($ per household in population)					
cable operator	20.41	20.02	19.58	19.40	19.21
cable networks	16.21	15.78	17.37	17.54	17.19
satellite*	5.10	4.97	4.21	4.17	5.50

* notice that satellite is assumed to not react to cable unbundling, for reasons discussed in section 7.1.

Table 8b. Mini-tiers by owner – outcomes for the networks
(% change relative to original bundling, column (a) of table 6)

	(a) original license fees	(b) P_{basic}=15, orig. fees	(c) lump-sum license fees	(d) revenue-sharing	(e) proportional increase
% change in viewership					
among cable subs	-2%	-4%	9%	10%	-7%
total cable+satellite	-1%	-2%	2%	2%	-3%
% change in the number of subscribers					
among cable subs	-21%	-25%	-9%	-9%	-27%
total cable+satellite	-17%	-21%	-14%	-13%	-19%
% change in license-fee revenues					
among cable subs	-21%	-25%	0%	3%	-5%
total cable+satellite	-17%	-21%	-7%	-5%	-4%
% change in total revenues (advertising + license fees)					
among cable subs	-11%	-14%	5%	6%	-6%
total cable+satellite	-9%	-11%	-2%	-1%	-3%
% change in viewership (among cable subs), by tier					
Disney	-7%	-10%	9%	10%	-13%
Time Warner	1%	0%	10%	10%	0%
Fox	-16%	-15%	5%	5%	-41%
NBC Universal	0%	-2%	6%	7%	-3%
Viacom	6%	4%	14%	14%	3%
other	1%	-1%	9%	10%	-2%
% change in license-fee revenues (among cable subs), by tier					
Disney	-20%	-24%	0%	3%	-4%
Time Warner	-10%	-14%	0%	3%	5%
Fox	-42%	-42%	0%	3%	-30%
NBC Universal	-26%	-29%	0%	3%	3%
Viacom	-21%	-27%	0%	3%	1%
other	-7%	-14%	0%	3%	3%