The Use of Full-line Forcing Contracts in the Video Rental Industry*

Justin Ho†
Katherine Ho‡
Julie Holland Mortimer§

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Abstract

Digitalization of information goods substantially affects firms' incentives to pursue bundling and other contractual arrangements, making bundling an important current policy issue. Realistic analyses of the use and implications of bundling require detailed data on both supply arrangements and consumer demand, including substitution between products. We analyze bundling in the video-rental industry, for which we observe extensive data on supply and demand. Our model captures key details of the market, which determine firms' contractual choices, and sheds light on the implications of these decisions. The empirical approach provides a model for how to analyze bundling when detailed data are available.

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†Department of Economics, Harvard University, Cambridge, MA 02138. Email: jho@fas.harvard.edu

‡Department of Economics, Columbia University, New York, NY 10027. Email: katherine.ho@columbia.edu

§Department of Economics, Harvard University, Cambridge, MA 02138. Email: mortimer@fas.harvard.edu

1 Introduction

Digitalization greatly enhances firms' abilities to implement new product bundling strategies and to pursue alternative distribution methods for information goods. They have also fundamentally changed the manner in which most media are purchased and consumed.[1] As a result, new digital technological abilities have brought bundling to the forefront of policy debates in many media industries such as cable television, movies, music, and books. These markets for information goods are quickly becoming a large and important part of the digital economy, and they are characterized by vertically-separated supply chains in which bundling arrangements are frequently adopted. However, the reasons why firms choose to adopt bundling contracts in vertically-separated markets are often not completely understood, especially from an empirical perspective.[2]

The impact of bundling (both for firms, and for welfare more generally) hinges critically on the nature of demand.[3] Different correlations in tastes across products and markets lead to very different impacts of bundling, and therefore, different decisions by firms regarding their use of such contractual arrangements. In markets for information goods, the nature of the product itself is important for understanding the impact and use of bundling and other contractual arrangements within the supply chain. Specifically, once a consumer has acquired an idea or the content of an information good, she does not need to acquire it again. This means that unlike other non-durable consumption goods, products in these markets are continually refreshed.[4] This constant churn of new content impacts the way one analyses both demand and supply in these settings. On the demand side, the frequent rotation of products increases the level of detail one needs to observe in data from these markets, while simultaneously providing variation in choice sets over time that may be helpful for identifying demand patterns. On the supply side, the constant refreshment of products may give different incentives to firms to pursue bundling and alternative distribution arrangements over time as their product lines change. Unfortunately, it is rare to simultaneously observe detailed data on both consumption patterns across different choice sets and the precise contractual forms

[1]For example, record labels typically bundle recorded songs into albums, while iTunes and other music downloading services may allow consumers to download songs individually, access them through monthly fees, or purchase them in a wider variety of different bundles.

[2]Predicting the use and impact of bundling and other contractual arrangements often requires an empirical approach, because of the wide range of possible theoretical explanations and predictions. Much of the theoretical literature on bundling addresses the reasons why upstream firms might choose to offer pure bundling contracts. The most closely-related theoretical work is Burstein (1960), which views full-line forcing as a means of achieving the effects of vertical integration. A more recent strand of the theoretical literature focuses on the ability of bundling to leverage a firm's strongest products to induce retailers to replace competing upstream products with products from the bundling firm. See for example, Whinston (1990), Choi and Stefanadis (2001), Carlton and Waldman (2002) and Nalebuff (2004).

[3]Another strand of the theoretical literature examines the ability of bundling to implement price discrimination. Upstream firms may profit from tying their products if the preferences of the downstream firms for each good are negatively correlated. Adams and Yellen (1976) provide the first formal model of price discrimination through tying, building on a seminal paper by Stigler (1962). Their work is generalized by McAfee, McMillan and Whinston (1989) and Salinger (1995) among others.

[4]For example, television shows offered on a particular cable channel change regularly and affect consumer substitution patterns across bundles of channels and therefore cable companies' incentives to bundle. Similar turnover characterizes movies, music and books.

and bundling arrangements utilized between upstream content providers and downstream retail outlets.

In this paper we provide an empirical study of a nascent example of bundling in an information-goods market, specifically the video-rental market during the period of 1998-2002.[5] Similar to the music, cable television, books, and other information industries, the movie rental industry is characterized by the continual introduction of new content, and demand for content that tends to peak early and decay relatively rapidly over time. Movie distributors and video retailers acquired the ability to monitor rental transactions during this period, which led to a series of innovations in the vertical contracts used for distribution. The initial contracting innovation involved a move from linear pricing to revenue sharing.[6] The second major contracting innovation introduced bundling, or full-line forcing (FLF), in which retailers were offered advantageous contractual terms in exchange for agreeing to carry the full line of products released by a distributor during a one-year period.

An important advantage of studying this market is the availability of an extensive dataset that provides detailed information on consumer demand for products within each bundle. This enables us to estimate a realistic demand model, which forms the backbone of our bundling analysis. We then develop a model of retailers' portfolio and contract choices and estimate the model with a moment inequalities approach. Using the estimated parameters, we calculate the benefits to upstream and downstream firms of their decisions to adopt bundling contracts. To our knowledge, this is the first empirical analysis of bundling in an information goods industry that has panel data on the content being bundled and on consumer demand for that content. As such, it provides a unique analysis of how demand patterns and content characteristics drive bundling decisions.

Our model has three main elements. First we estimate a flexible nested-logit demand system that captures demand interactions between titles and across title categories and allows for decay over time. The impact of full-line forcing contracts is to change the composition of the choice set, the inventory of each title and the price per rental. Thus, the focus of the demand system is to capture the impact of adding or removing a title from the consumer's choice set, and of changing inventory and price, on rentals of the relevant title and all other titles offered by the retailer. The second component of the model considers the retailer portfolio choice problem. This is a difficult problem because, given the demand substitution effects already noted, the retailer's choice of contract type for a particular title is affected by its choices for all other titles offered by all distributors that are currently available in the store. We address this problem using a moment inequalities approach (following the approach developed in Pakes, Porter, Ho and Ishii (2007)). Rather than defining a detailed model that predicts retailers' equilibrium strategies, we focus on estimating the final piece of information needed to analyze retailers' and distributors' choices of contract types: the value (positive or negative) of holding inventory. The inequalities are sufficient to place bounds on this value. This approach reduces the difficult portfolio choice problem to a simpler analysis that is much more feasible to estimate. The third component of the model is to use the estimated parameters in counterfactual experiments to infer the impact of FLF contracts on

[5]This setting pre-dates most of the digital applications that are currently driving many policy debates. However, although the video medium was not digitalized during this period, the cost of reproduction was low, which introduced many of the same policy issues that other digital media now face.

[6]This innovation is studied in Mortimer (2008).

the profits of distributors and stores.

We note that, while the institutional details included in our model are of course different from those that would be required in an analysis of a different industry, our extensive demand-side data enable us to provide a role model for the issues that should be accounted for in bundling analyses more generally. In particular, a detailed analysis of demand substitution effects is needed to predict the impact of adding or removing a product to or from a bundle on own-firm and competing-firm profits. A careful model of the supply side is needed to obtain information on costs to the firm of increasing the number of products offered. Without these components, our ability to understand the impact of bundling on firms and consumers may be incomplete.

Our results provide useful information on how firms make decisions in this market. Of the nine major distributors that offer some form of revenue sharing arrangement, five also offer FLF terms. The majority of retailers adopt FLF contracts from at least one distributor. We estimate a positive value of holding inventory for the majority of retailer-title pairs and use the estimated supply and demand parameters to analyze the decisions of both upstream and downstream firms during a 12-month period. Of the nine major distributors that we focus on, one is not active in the year we analyze. Two other distributors begin offering FLF shortly after our period of analysis. Among the six remaining distributors, two offer FLF during this period and four do not. For these six distributors, we simulate the optimal contract choices of both upstream and downstream firms. We find that distributors make profit-maximizing decisions when choosing to offer FLF. Retailers purchasing titles from the distributors that do not offer FLF have high take-up rates even in the absence of FLF contracts. Thus, in the counterfactual world in which these distributors offer FLF, retailers switch to the more generous FLF terms at a high cost to the distributor. In contrast, the distributors who offer FLF terms benefit from the contractual form by drawing in new retailers who would not take up the titles under other contractual forms. Interestingly, we also estimate that one of the "FLF distributors" would lose money on average from FLF contracts for retailers that do not take a FLF contract in reality. These retailers differ in several observable dimensions from retailers who take FLF from the studio. For example, FLF retailers are less likely to compete with a local Blockbuster Video outlet, and much more likely to use non-bundled revenue-sharing arrangements.

Markets for which detailed supply-side arrangements are observed are often markets for which demand data are limited. As a result, there are very few previous empirical papers on bundling within a supply-chain setting. Most relevant to our study, Crawford and Yurukoglu (2008) estimate the welfare effects of bundling in the retail cable television market. An important advantage of their study is their focus on an industry for which bundling is currently an important concern for policy makers, both at the retail level (bundling to consumers) and within the supply chain. A limitation of their study is that data on consumption behavior (i.e., consumers' choice of content) is not observed at a detailed level. In other related analyses of the cable television market, Crawford (2008) examines discriminatory incentives for bundling, and Byzalov (2008) analyzes the welfare impacts of various restrictions to bundling arrangements. This last study tracks detailed data on consumption behavior, but does not observe detailed information about the contractual arrangements on the supply side.[7]

[7]In addition, Hastings (2009) provides an empirical assessment of upstream price discrimination in the

Mortimer (2008) studies the impact of product-by-product vertical distribution arrangements on profits and consumer surplus, but does not address the issue of product bundling in the supply chain, which is the focus of this paper. The focus on mixed bundling requires us to expand the data used in Mortimer (2008) considerably. First, we extend the data from two years to four in order to follow the adoption of FLF contracts. Second, we recover detailed monthly activity for each store-title pair because our focus on bundling requires us to implement a much more flexible demand system. In addition, we allow for a more flexible cost structure at the retail level.

The paper continues as follows. In Section 2 we outline the important institutional features of the industry; Section 3 describes the data. In Section 4 we provide an overview of the model. Section 5 considers demand, Section 6 covers the inequalities methodology, and Section 7 describes our counterfactual analyses. Finally, Section 8 concludes. An appendix provides additional summary statistics and reduced-form analysis.

2 The Video Rental Market

The video rental industry has two primary tiers: distributors, who distribute movies, and video rental stores, who acquire movies and offer them for rental and sale to consumers. Three different contractual forms are used to distribute titles targeted to the rental market from distributors to rental stores. The first is linear pricing (LP). Under linear-pricing contracts, a store purchases a title from the distributor for a fixed cost per tape, usually between $65 and $70. They may also offer quantity discounts (introducing second-degree price discrimination).

The second contractual form is revenue sharing (RS). Under revenue-sharing contracts a rental store leases a title from a distributor for a low upfront cost per tape, but receives a share of the revenues generated by a title. In the typical RS contract, the distributor charges an upfront cost of around $8 per tape and receives about 55% of the rental revenue. The inventory decision of the rental store is often constrained by both maximum and (often binding) minimum quantity restrictions. RS and LP contracts are both implemented on a per title basis. That is, for each individual title, the rental store chooses both whether to purchase the title and the contractual form. All titles available under RS terms are also available under LP terms, but not all titles available under LP are offered under RS.

In contrast, the third form of contract, the full-line forcing (FLF) contract or output program, requires the rental store to purchase all titles released by the distributor during the period of the agreement (typically 12 months) and to take them all under the same contract type.[8] In many other respects FLF contracts resemble RS contracts. For each title

retail gasoline market. At the consumer level, Chu, Leslie and Sorensen (2007) uses data on theatre tickets to examine the profitability of simple alternative pricing strategies to mixed bundling, and shows that these alternatives can yield profits that are very close to those of mixed bundling. There is also a small literature that uses reduced-form analyses to investigate the pro- and anti-competitive effects of slotting allowances, which are paid by manufacturers to supermarkets in order to reserve shelf space for their products (e.g., Marx and Shaffer (2004)).

[8]Some exceptions apply: titles released by the distributor on sell-through pricing contracts are exempt, and several distributors allow for limitations on the total number of titles that a retailer must accept within any given month. Usually, this limit is three titles per month: if the distributor releases more than three titles in a month (a rare event), the retailer is only obligated to accept three of them. Finally, FLF contracts

taken on full-line forcing terms, the distributor receives an upfront payment per tape and a share of the revenues, both of which are usually lower than under RS contracts. The quantity taken by the retailer is again restricted to be within a range, where the lower bound (on average eleven tapes per title) is again frequently binding. All titles offered on FLF terms are also available through LP and RS.

Distributors have only a limited ability to price discriminate across retailers. The 1936 Robinson-Patman Act prevents them from offering different prices to competing buyers for exactly the same product. Furthermore, copyright laws permit stores to freely resell tapes purchased from distributors under LP contracts, which effectively limits their ability to use second-degree price discrimination. We do observe a few volume discounts under LP contracts and some negotiated deals under RS (again based largely on volume), and our estimation takes these into account. There may be some volume discounts for LP contracts that we do not observe; we include the effects of these discounts on stores' costs in our inequalities analysis. The maximum and minimum quantity requirements for RS contracts also vary by distributor with the box office of the movie and the size of the store: this variation is observed in our data and accounted for in our model.

In addition to setting terms for each contractual form, the distributor can, in theory, choose which contractual forms to offer. In particular, one might expect the distributor to choose not to offer LP contracts since these are the least flexible contractual arrangements. In reality, however, RS contracts are not widely used before the end of 1997, and FLF contracts are not introduced until the middle of our dataset, in February 1999. One likely reason is that both contractual forms require extensive computer monitoring of millions of transactions, and only about half of the stores in the industry had the technology to adopt these contracts by 1998.[9] Thus, eliminating LP contracts during the period of our data may have substantially reduced distributors' target market.[10] This implies that rental stores can discipline the distributors by opting to take LP contracts when revenue-sharing splits are not satisfactory.

One further institutional detail concerns "sell-through priced" titles (STP). These include, for example, children's movies and some very popular titles: the distributor sells these movies to all buyers, including video rental stores, for relatively low prices, often around $20-25 per tape.[11] There is no contract choice for sell-through priced titles because these titles are not available under any other contractual terms. We condition on these titles' existence in the demand model and account for them in our calculation of the store's total returns in the inequalities framework but do not model the distributors' contract choice.

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also typically include opt-out clauses for movies with 'objectionable' content.

[9] Our dataset includes only stores that have the technology to utilize revenue-sharing terms.

[10] Distributors are effectively prevented from offering LP contracts only to stores without revenue-sharing capability by the Copyright Act of 1976. This states that the owner of a lawful copy can "sell or otherwise dispose of" the copy and implies that retailers with the ability to participate in revenue-sharing agreements cannot be excluded from choosing LP contracts for a title unless LP contracts are not offered to any retailers for that title.

[11] Sell-through priced titles are exempt from the requirement that stores choosing a FLF contract take all of the distributor's titles on FLF terms.

3 The Dataset

Our primary data source is Rentrak Corporation, an organization that distributes movies under revenue-sharing and full-line forcing contractual arrangements. They also monitor all titles at participating retailers, and facilitate payments between retailers and distributors under the RS and FLF contracts.[12] The complete dataset combines information from previous studies (Mortimer 2007 and 2008) with additional information from Rentrak on FLF contracts. Over 11,000 retailers used Rentrak between 1998 and 2001, accounting for over half of all retailers in the industry. Approximately 4,000 of these are Blockbuster Video and Hollywood Video stores: we do not observe their transactions. We observe 7,525 retailers (over 30% of all stores in the industry), ranging in size from single-store locations to a chain with 1,652 locations. For each store we observe transaction data between January 1, 1998 and June 30, 2002 and follow 1,025 titles released during this period.[13]

For each store we observe the total monthly revenue of a store, its zip code, the size of its chain and considerable detail regarding product mix, such as the overall percentages of game, adult, rental, and sales revenues. We also observe the date the store joined the Rentrak database and the date the store left Rentrak if applicable. The vast majority of store exits (over 90%) represent store closure.[14] The zip code information allows us to supplement the primary Rentrak data with several additional sources. Phonebook listings of competing video retail locations in each year, as well as separate indicators of competing Blockbuster and Hollywood Video locations are included. We also merge in data from the 2000 US Census on the local demographic characteristics of each store. We define a local market as a zip code area: the average zip code contains approximately 24,000 people and 2.6 video retail stores. Larger areas, such as 4-digit zip codes or Metropolitan Statistical Areas (MSA's) are also feasible ways of defining markets but are probably too large for most video store customers.

Every movie title is tracked individually, using a title identifier but not the actual title name. For each title we observe a distributor identifier (but not the actual distributor name), its month of release to video, genre (i.e., Action/Adventure, Children/Family, Comedy, Drama, Horror, Romance, and Sci-Fi), and MPAA rating (G, PG, PG-13, and R). We also observe box-office categories, denoted A, B, C and D. Titles in the A category have theatrical box-office revenues of more than $40 million; those in the B and C categories have revenues of $15-40 million and $0.25-15 million respectively. Titles in the D category do not have a theatrical release: these are "direct-to-video" titles such as instructional or exercise videos. Many of these titles are bought only by a single store; we exclude D titles from our analysis. The dataset includes 212 A titles, 195 B titles, and 618 C titles.

In addition to title characteristics, we observe the terms of the RS and FLF contracts offered to retailers for each title, as well as retail prices under LP and STP contracts. Rentrak

[12] Rentrak receives a small cut of the distributors' profits under RS and FLF contracts. While it may have a role in persuading distributors to offer RS and FLF contracts, it does not influence stores' choices conditional on the contract types offered for each title. We therefore exclude Rentrak and wholesalers from our model.

[13] Full-line forcing arrangements continue to be an important contractual form in the industry for the DVD format. However, unlike for VHS in the period that we study, the focus of FLF contracts for DVDs has been older blockbuster titles or "classic" movies.

[14] For 1,122 stores, data collection ended for titles released after December 1999. We include these stores in both our demand and supply models up to that date.

does not provide the actual wholesale prices paid by retailers under linear-pricing terms: we adjust the retail price to reflect the true wholesale price using guidance from Rentrak and industry sources (see Mortimer 2007 for details).

Finally, at the store-title level we observe the type of contract chosen by the retailer and the number of tapes purchased. Transaction data are recorded at the store-title-week level, and provide information on the number of rentals per tape, total weekly revenues per tape, and inventory levels (which do not vary across weeks). We discard observations for titles released after January 1, 2002 so that rental activity for each title is tracked for at least 6 months. We aggregate weekly rental data to the month level (both the number of rentals and average rental prices for the month) in order to smooth out any weekly demand fluctuations. We therefore have 54 months of transaction data for titles released over 48 months.

We take several steps to clean the dataset. First we exclude observations where average price per rental is less than $0.50 or more than $7 and those where store demographic data are missing. We drop five titles whose wholesale price is zero. Ten titles have two values for release month: for nine of them the majority of observations have the same (earlier) value so we assume that the later date refers to a special edition and switch to the earlier date for all observations. The tenth title has half the observations with one release date and half with another; we drop this title from the dataset. We are left with 6,393 stores, 961 titles (201 in the A box-office category, 188 B titles and 572 C titles) and 59 distributors in the dataset.

Forty-seven of the 59 distributors produce fewer than 6.5 movies per year on average, and 35 of these distributors release fewer than 4 titles during the four years of our sample. On average, the 47 small distributors each release about 2.2 titles per year, which accounts for about 23% of all titles. Two of these small distributors offer FLF contracts, which cover a total of six titles.[15] However, most of these distributors do not have enough titles to consider FLF terms. The remaining 78% of titles are released by 12 "major" studios. The average number of titles released per year for the major studios is about 16. Among these 12 studios, three do not offer any type of sharing contract (RS or FLF). Of the remaining 9 studios that offer some form of sharing contract, 5 also offer FLF terms. The first FLF contract appears in the dataset in February 1999.

Of the 6,393 retail stores in the clean dataset, 6,358 participate in at least one LP contract during the period of the analysis, 6,150 participate in at least one RS contract, 5,111 participate in at least one FLF contract and 6,171 participate in at least one STP contract. On average stores take 42% of the titles released per distributor-year. The proportion is higher for FLF distributors (54%, or 41% if we include only stores that have no FLF contracts with the relevant distributor and 73% for stores that do FLF with the distributor at any time) than for other distributors (39%). For the largest 12 studios, on average stores take 59% from non-FLF and 60% from FLF distributors (43% for stores that do no FLF and 73% for stores that do FLF with the relevant distributor).

Stores are categorized into ten size "tiers," with tier 1 containing the smallest stores and tier 10 the largest stores. The average number of titles taken per month increases with store tier from 9.9 in tier 1 to 13.4 in tier 6. It then falls in each subsequent tier to a low of 11.1 in tier 9, and back up to 12.0 in tier 10. The average number of tapes taken per month

[15] One offers FLF for their whole portfolio of titles (4 titles released during 2000 and 2001). The other offers FLF in May 2001; this covers 2 of the 4 titles that the distributor released in the 2001 calendar year.

increases with every store tier, from 43.9 in tier 1 to 391.6 in tier 10. "FLF stores" take an average of 1.5 more titles per month (12.4 vs. 10.9), and 49.4 more tapes per month (138.6 vs. 89.2) than "non-FLF stores."

Additional summary statistics are provided in Tables 1 and 2. Table 1 sets out average contract terms, numbers of rentals, prices and inventories for each contract type. Averages are taken across store-title pairs. The average estimated wholesale cost for LP contracts is \$66.82, compared to an average upfront cost of \$8.46 for RS contracts, \$3.61 for FLF contracts and a cost of \$15.16 for STP contracts. Retailers on average keep 46% of revenues under RS contracts, and 59% of revenues under FLF contracts. The average minimum (maximum) number of tapes per title is 10 (24) for RS contracts and 11 (23) for FLF contracts. Average month 1 rentals are highest under RS contracts but the decay rate is also greatest for these titles; LP titles have slightly higher demand in month 2 and substantially higher demand in every other month.

Average inventory levels are highest for titles purchased under sell-through pricing and RS contracts and lowest for those under LP contracts. Not surprisingly, retailers also extract the largest number of rentals per tape for titles purchased under LP contracts. Average rental prices differ very little across contract types: the negative effect of the lower cost per tape under RS contracts compared to LP contracts is offset in part by the positive effect of the revenue-sharing component.[16] However, a regression of price on indicators for months since release to video, by contract type, indicates that prices fall faster for RS titles than for LP titles. This may indicate that the price-increasing effect of a high cost per tape under LP slightly outweighs the opposing effect of the two-part tariff under RS. It also implies that the margin on which prices adjust may be the timing of removal of the "new release" sticker, with concurrent price reduction or increase in the rental period (and resulting decrease in late fees collected).

Table 2 summarizes the number of titles released by distributors, and taken by stores, under different contract types. The majority of titles in our data are offered under LP contracts; approximately 50.5% are also offered under RS contracts. No FLF contracts are offered in the first year of our data; a total of ten titles are offered on FLF terms in year 2, eighteen in year 3, and 38 in year 4. Table 2 further reports that stores on average take many more titles on LP contracts than on other contract types. Additional summary statistics that break these numbers down by contract type and set out store size distributions across different contracts are provided in the appendix.

4 Overview of the Structural Model

The summary statistics provide evidence that the majority of large distributors choose to offer FLF contracts. A large proportion of retailers choose to take them up. A structural model is needed to understand whether these choices are profitable: that is, to predict the differences in consumer demand, retailer revenues and costs and distributor revenues between the observed scenario and that where FLF contracts are not offered or not taken. The modeling approach we use has three elements. First, we estimate a demand system that

[16] Once the inventory has been purchased the store has an incentive to price LP titles below RS titles in order to draw consumers to the titles for which they capture 100% of the rental revenues.

captures the demand interactions between titles and across title categories. The second step is to use moment inequalities to infer the store's value or cost of holding inventory. The third step is to use the estimated model to run counterfactual experiments to infer the impact of FLF contracts on the profits of distributors and stores.

Before discussing the details of the model it is helpful to consider the factors the retailer takes into account when choosing between contract types. First, and most obviously, the price and revenue-sharing terms of the contract are important. LP contracts are likely to be chosen in preference to RS when the store expects high demand for a title.[17] Second, the retailer considers the inventory restrictions for both RS and FLF contracts: in both cases the minimum quantity restriction is on average higher than the average number of tapes per title taken under LP contracts and is often binding in our data. The restriction affects retailers both by increasing the cost of taking the title (the number of tapes to be purchased and the cost of storing tapes) and also potentially by increasing the expected level of demand for the title. For example, a higher inventory level implies a higher number of tapes on the shelf and therefore a title that is more visible to consumers. It may also act as a signal of high quality or a blockbuster title. Thus, high inventory may lead to high initial demand: consumers find out about and choose to rent the title more quickly than they would have otherwise. This may also affect later demand for the title because of a durable goods issue: if a consumer rents a title in one month he is unlikely to rent it again later. We allow for this by including both inventory and inventory-month interactions in our demand model.[18]

There are three other potential effects of an increase in inventory. First, increasing the number of tapes taken per title (or the number of titles) may increase retailer profits by attracting new consumers to the store, inducing them either to switch from other video rental stores or to enter the market for the first time. Second, if the inventory of title X is increased and some other title Y is a close substitute released in the same month, then its rentals are likely to fall which could imply an overall reduction in retailer profits for this pair of titles.[19] Finally, if consumer preferences are correlated across months, then a change in X's inventory level in month 1 may affect title Y rentals in later months and this too may impact retailer profits.[20] Our model captures the second of these three effects; the impact of the other two effects on retailer profits is included in the cost of taking an extra tape, estimated in the inequalities analysis.

It is worth noting here that stores do not in general face physical inventory constraints. If they come close to running out of shelf space when storing tapes title-page-forwards, they simply store them spine-forwards (starting with the oldest titles). If they run out of space again they can hold some tapes under the counter or in a back room. Thus, the choice of inventory levels affects demand but not the number of titles that can be displayed.

[17] Mortimer (2007) demonstrates this in a market that is consistent with the assumptions in our empirical model.

[18] A second mechanism through which inventory affects demand is stockouts. We have no data on stockouts and therefore cannot fully model this issue. We estimate demand at the store-title-month level, therefore allowing consumers to substitute intertemporally within a month when a stockout occurs.

[19] For example, this would be the case if title Y is taken on LP or sell-through pricing terms but X is taken on RS or FLF so that the proportion of the rental revenues captured by the store is higher for Y than for X.

[20] Again the impact of this substitution effect on store profits depends on the contract types of titles X and Y.

5 A Model of Demand

5.1 Demand Methodology

The data provide information on the number of rentals and the total revenues for each title-store in each week. We aggregate this weekly information to the month level for two reasons. First, stockouts can lead to shifts in observed weekly transactions that are unrelated to true demand; allowing consumers to substitute across weeks within each month mitigates this problem. We do not observe periods of stockouts, which can include tapes that are lost or returned late. This is primarily a limitation that results from the rental nature of the product. Thus, it is difficult to implement the corrected demand estimator proposed in Conlon and Mortimer (2008) to account for stockouts explicitly. Second, we account for the changing set of competing titles due to the release of new titles over time: this would not be feasible in a weekly framework.[21] Our methodology for aggregating to the month level is as follows. For any title released in month one, we sum over weeks 1 through 4 to generate month 1 demand.[22] Similarly, we sum over weeks 5 - 8 to generate month 2 demand, weeks 9 - 13 to generate month 3 demand, and weeks 14 - 17 for demand in month 4. Finally we aggregate all remaining weeks into a "months 5 and above" observation. Approximately 84% of all rentals occur in the first 4 months after a title's release to video.[23] We construct prices at the monthly level by dividing monthly revenues by monthly transactions. Finally, we drop store-title-month observations with zero rentals/revenues.

We define a title's competitors in each month as the titles that are released during the previous 4 months (including the current month). This implies an assumption that titles released more than 4 months ago do not substitute for current releases. Only titles in this moving window are included in the analysis for the relevant month.[24]

We estimate a nested logit model of demand with nests defined as interactions between genre and box office class groups (i.e., "A" comedies).[25] The demand equation is:

$$u_{ijmt} = \delta_{jmt} + \zeta_{igmt} + (1 - \sigma)\varepsilon_{ijmt} \tag{1}$$

[21]Using weekly demand when the choice set changes every week would require that we estimate over 35 different choice sets for each title if we allowed for four months of activity per title. This is computationally impossible for titles that are held by a small number of retailers, and difficult even for widely-held titles, when we wish to incorporate sensible decay patterns.

[22]We replace missing or negative values for weekly revenues or transactions with zeros.

[23]Note that titles released in the last week of a month are tracked for just one week in the first month rather than 4 weeks. This leads to downward bias in the demand estimates for those titles. Fortunately, there appears to be no correlation between this and distributors, genres, or any other observable characteristic of movies, and based on industry discussions, we assume that this form of truncation is random. In addition, the "month 5+" revenues for titles released later in our time period are smaller than those for titles released earlier.

[24]Our full dataset includes titles released between months 1 and 54 of our panel. We exclude months 1-4 and months 49-54 from our analysis. This ensures that we include only titles for which we observe at least 6 months of activity and only months for which we observe the full choice set (including titles released in the previous 4 months). We truncate the data in an analogous way for stores that enter or exit the sample.

[25]This can be interpreted as a random coefficients model with the random coefficients on group dummies. See Berry (1994) for a discussion. Since genre and box office category are the main sources of differentiation between titles (and 2 of our 3 observable title characteristics) this seems a natural structure for modeling heterogeneity in consumer preferences.

where i indexes consumers, j titles, m stores, t months and g the genre/class group of the title. The term ζ_{igmt} is an idiosyncratic preference term common to all titles in group g and ε_{ijmt} is an idiosyncratic preference term specific to consumer i and the product indexed by jmt. Cardell (1997) gives conditions such that $[\zeta_{igmt} + (1-\sigma)\varepsilon_{ijmt}]$ has an extreme value distribution with $\sigma \in [0,1]$ parameterizing the correlation of the idiosyncratic preferences within group ($\sigma = 0$ means no correlation; $\sigma = 1$ means perfect correlation). Price varies across titles, geographic markets and months. The term δ_{jmt} is specified as:

$$\delta_{jmt} = \delta_j + \gamma_j z_m + \eta_m + \theta_t + \beta_t x_j + \lambda_t c_{jm} - \alpha p_{jmt} + \xi_{jmt} \tag{2}$$

where δ_j is a title fixed effect, η_m is a store fixed effect, θ_t is a month fixed effect, p_{jmt} is the average price per rental of the tape at store m in month t, and c_{jm} is the inventory of title j at store m. The last term ξ_{jmt} captures any unobservable quality of renting title j in market m in month t. This could include things such as local promotions of a particular movie in a month. We interact title dummies with store characteristics: these describe the demographics of the store's market. The variables are the percent white, the percent single and the percent with children. We therefore permit each store to predict the demand for a particular title based on the demographics of local consumers.[26]

The decay rate θ_t captures two effects. The first is the simple idea that demand for a title falls over time as advertising and word-of-mouth "buzz" decrease. The second is the durable goods issue noted above: if a consumer rents a particular title in month 1 he is unlikely to be in the market for the same title in month 2.[27] We would ideally account for this effect by including title-month fixed effects, allowing for a completely flexible decay rate for each title; unfortunately the number of titles is too large for this to be feasible. Instead, we interact month fixed effects with title characteristics (box office class, genre, and rating) and double and triple interactions of these three groups of variables.[28] This implies constraining the decay rate to be the same for all titles in a particular box office category-genre-rating cell.[29] Finally, we also interact the decay rate with the store's inventory level for the particular title. This accounts for the different average inventory levels associated with different contract types.

Integrating out the idiosyncratic preference terms yields the following equation for estimation:

$$\ln(s_{jmt}) - \ln(s_{0mt}) = \delta_j + \gamma_j z_m + \eta_m + \theta_t + \beta_t x_j + \lambda_t c_{jm} - \alpha p_{jmt} + \sigma \ln(s_{jmt/gmt}) + \xi_{jmt} \tag{3}$$

[26] We could also have interacted store dummies with title characteristics. We choose not to do this partly because our title characteristics are not very informative - see below for a discussion. In addition, the implied effect, that the "quality of a store" differs across types of movies, would identify essentially the same effect as the $\gamma_j z_m$ term: that stores serving different demographic groups expect different movies to be popular.

[27] There is also a potential seasonality effect: a title released in December may have different demand from one released in June. This effect is absorbed into the title fixed effects, although not differentially across months.

[28] We include only interactions for which there are non-trivial numbers of observations. For example, there is only one PG action/adventure rated movie so we combine that cell with PG13 action/adventure movies.

[29] There is one further issue which we would ideally account for by including title-month fixed effects. If title A is introduced in month 4, it competes with and therefore affects demand for title B in month 7. It therefore has an impact on residual demand for title B in months 8-10. These interactions between months would be perfectly accounted for if we had a fully flexible time trend for each title.

where $s_{jmt/gmt}$ is the share of title j within group g at store m in month t. The outside option (with share s_{0mt}) is doing something other than watching a new release movie. Its share is calculated from a market share assumption: we assume that the market size (denoted M) is equal to 4 movie rentals per month per household in the store's zip code.

One further aspect of the data complicates the estimation process: we very rarely observe more than one store per zip code (although we do know the number of stores that exist in each zip code). We therefore cannot explicitly include the whole choice set in the demand estimation. We address this by treating each store as a monopolist in its market. If N stores actually exist in the market (according to the phone book) we assign $\frac{1}{N}$ of the total population to the observed store; we model demand for the store as coming from just that subset of consumers. This implies an assumption that stores in the same market are identical and have independent populations of potential customers; a change in characteristics might attract more customers from that population but would not steal business from other stores. We interpret this as an assumption that, when a consumer visits a video rental store, if he does not find the title he is looking for he will either rent something else or go home rather than visit a different store. The relevant dimension of competition, particularly since we are considering bundling, is that across distributors within a store rather than that across stores. We model the former carefully but do not go into details on the latter.[30] In reality, if one store improves its offering over time by adding titles or tapes, it may gain market share from other local stores. This effect is identified in the inequalities analysis. However, we do not model other aspects of inter-store competition such as pricing and specific portfolio choices. One obvious concern is with Blockbuster, which has FLF contracts for a large number of titles and frequently has a larger portfolio than its competitors. We treat Blockbuster like any other store in the demand equation (in that, if there are 2 non-Blockbuster and 1 Blockbuster stores in the market, then each observed store's demand is predicted assuming a population $\frac{1}{3}$ of the total in the market). The store fixed effects absorb any differential effect that a Blockbuster dummy would have on demand, absent entry or exit by Blockbuster outlets in a market during our sample.

Three variables in the demand model are likely to be endogenous: price, inventory, and the share of the title within its group ($s_{jmt/gmt}$). The demand model includes store, title and month fixed effects, as well as interactions between title dummies and observable demographic characteristics of a store's market. Thus, we are concerned about endogeneity only through unobservables that are not absorbed by these effects, and that affect changes in prices, inventory and the $s_{jmt/gmt}$ term. We instrument for inventory using the average inventory of the same title across stores of the same tier.[31] Two assumptions are needed to make this a valid instrument. First, that the costs or constraints of taking inventory for a

[30] We could alternatively include all observed stores in each market in the estimated demand system and extend it to include all the stores that actually exist in the market assuming that those we do not observe are identical to those in the data. We would then simulate the change in demand for store m's titles when all stores simultaneously change their contracts and portfolios, probably assuming a symmetric equilibrium. Given the lack of data we expect this to add little to our results.

[31] Tiers are defined by Rentrak for the purpose of defining stores' max and min quantity requirements. We assume that they are exogenous to the demand equation modeled here. In all cases we take advantage of the full variation in the data by taking averages over stores in all regions, even when the demand model is run separately for different regions.

particular title are correlated across stores of a particular size, implying that similar-sized stores make similar inventory choices. Second, we assume that demand shocks, except those that are captured by the fixed effects δ_j and $\gamma_j z_m$, are not correlated across markets. Examples of shocks captured by the fixed effects are title-specific unobserved advertising, or particularly high advertising for a children's movie in towns with a high fraction of households with children (since that is included in $\gamma_j z_m$). Demand shocks that remain in ξ_{jmt} and that are not correlated across markets could include local advertising and word-of-mouth buzz.

Two particularly relevant sources of variation in the instrument for capacity are unobserved volume discounts and the impact of minimum and maximum quantity restrictions. Unobserved volume discounts can be significant for titles taken on linear-pricing and sell-through pricing contracts, impacting the cost of acquiring capacity. Furthermore, the ability of stores to take advantage of these discounts varies significantly by store size. For some titles, quantity targets necessary for the discounts are explicitly set based on the store size, or based on the store ordering history for similar titles.[32] For other titles, all stores face the same discount targets.[33]

For titles taken on revenue-sharing contracts, the variation in the instrument largely reflects the differential impact of minimum and maximum quantity restrictions implemented by the distributor. As noted earlier, titles taken on revenue-sharing contracts are subject to minimum and maximum quantity restrictions, and these restrictions are set separately by store tier (size) and title. When the quantity restrictions are binding there is, by definition, an impact on the store's capacity choice. For A titles, restrictions are binding for over half of the store/title combinations, substantially impacting capacity decisions. Furthermore, the extent to which these restrictions bind tends to vary substantially by store tier. Minimum quantity restrictions are less frequently binding for larger stores, with the smallest stores (tier 1) facing binding minimum quantity restriction almost 3 times more frequently than the largest stores (tier 10). Maximum quantity restrictions are most frequently binding for the smallest and largest stores, and are binding almost 2.5 times more frequently for these stores than for medium-sized stores. A similar pattern is observed for B and C titles, with the minimum quantity restriction binding somewhat more frequently, and the maximum quantity restrictions binding somewhat less frequently for these titles.

We instrument for $s_{jmt/gmt}$ using two variables: the log of the average number of movies of the same type (same box-genre-store group) in the month, where the average is across other stores in the same size tier that offer the relevant title, and the average of $\ln(s_{jmt/gmt})$ for the same title-month pair across stores of the same tier. The former instrument is correlated with the number of competitors to this title in this store. We take an average over other same-tier stores to account for any demand shocks that might affect both the store's portfolio choice and demand for title j. The second instrument is clearly correlated with $\ln(s_{jmt/gmt})$: like the inventory instrument, it is valid under the assumption that demand shocks, which

[32] For example, when distributing the movie "Velvet Goldmine," Disney created a target purchase quantity dependent on the average monthly store rental size (i.e., store tier). A rental store pays the traditional wholesale price for every copy purchased up to that store's target amount. The store could then purchase 200% more copies above the target for $20 per tape but return those tape to the studio after 18 weeks.

[33] For example, when distributing "Saving Private Ryan," Dreamworks offers a "Buy 10, Get 2 Free" discount to all stores. See Ioannou, Mortimer, and Mortimer (forthcoming) for more details.

might affect the share variable, are not correlated across markets.

We tried several instruments for price, including measures of variable costs and average prices of other similar titles. None of the instruments affected the estimate of the price coefficient. We believe the reason for this is that after including store, title and month fixed effects, the only unobservable we need to instrument for is at the store-title level, and our potential instruments are not correlated with this price variation.[34] We therefore conduct our analysis without instrumenting for price. We report in Section 5.2 the OLS results and those that instrument for inventory and the $\ln(s_{jmt/gmt})$ variable.

It is worth noting here that there are other potential demand methodologies. We would ideally interact title and store fixed effects in the nested logit; unfortunately the number of parameters to be estimated would be infeasibly large. Alternatively we could estimate a random coefficients model. However, this would imply replacing the (title or store) fixed effects in the model with (title or store) characteristics. The characteristics available to us are not sufficiently informative for this to be a useful approach.[35]

5.2 Demand Results

We run the demand model separately for 15 different geographic regions of the country since the dataset is too large for us to run the model using all the data together. We report results for the first geographic region in the top panel of Table 3.[36] The specification also includes title and store fixed effects and interactions between title fixed effects and store characteristics (percent of the market who are white, percent single and percent with children) and between month fixed effects and title characteristics (box office category, genre and rating and interactions between these). Column 1 of Table 3 reports results for the OLS regression. Column 2 adds instruments for within-group share and Column 3 also instruments for inventory. The R^2 is approximately 0.80 in all three models. The fact that the model fits the data well is particularly useful since our supply-side estimation stays within-sample in terms of titles and stores. We therefore use all the estimated fixed effects in our inequalitites and counterfactuals.

The price coefficient in the OLS regression is negative and significant, although small. We believe that the size of the coefficient reflects the fact that the demand model captures very short-run demand: rentals at a particular store in a particular month (selected from a set of recently-released titles). It is worth noting that this estimate is generated only by price variation that is not absorbed by the store, title and month fixed effects included in our model. It is perhaps not surprising that consumers exhibit only small responses to this

[34] Variation in price at this level (i.e., across months) does, however, exist: for example, after a title has been stocked at a store for several weeks, the store may remove the "new release" sticker from the tape and either drop the price or increase the rental period (implying lower collected late fees and a lower observed price). We believe this source of price variation is primarily determined exogenously because of the use of rule-of-thumb policies by video retailers in how they instruct employees to move tapes and update stickers on rental inventory.

[35] In the next section we regress the sum of the estimated title and store fixed effects on characteristics: the highest R^2 was 0.43.

[36] This region contains zip codes from 20000 to 24999. It includes areas in the mid-Atlantic such as Washington DC and parts of Virginia.

within-store price variation, as this in-sample price variation tends to be small.[37]

The estimated decay rates are intuitive: month 2 demand is higher on average than that in month 1 because observed revenues are left-truncated in month 1 for titles released mid-month. Demand falls in months 3 and 4 and rises again in month 5 because this last observation includes all subsequent revenues from the title. The inventory coefficient is positive implying that first-month demand increases with the number of tapes on the shelf. Not surprisingly, this generates a reduction in demand in later months (because residual demand is lower). The coefficient on within-group share, σ, is approximately 0.63.

Instrumenting for within-group share reduces the σ coefficient. This is consistent with the existence of demand shocks that affect both within-group share and total demand. Adding instruments for inventory reduces the coefficient on inventory and leaves the interactions between inventory and the decay rate essentially unchanged. There are two potential endogeneity stories here. First, if demand is expected to be high for a particular title then stores will choose high inventory levels, implying a positive bias on all inventory coefficients. Second, heavy advertising of a title in month 1 might lead stores to expect consumers to be impatient, demanding access to the title in month 1 rather than in later months. In this case, the unobservable would lead to high inventory levels and to high demand in the first month; instrumenting should reduce the inventory-month interactions for month 1 only. The results are consistent with the second intuition.

We repeat the demand analysis for each of the 14 other regions. The price coefficient is negative as expected for all but one of these. The problematic region contains 446 stores in the South West, including for example parts of AZ and NV. We exclude this set of stores from the remainder of our analysis.[38] There is some variation in results across the remaining 14 regions. The (unweighted) average price coefficient is -0.026. Its standard deviation across regions is 0.014; the minimum value is -0.050 and the maximum is -0.002. The average inventory coefficient is 0.014, standard deviation 0.004, minimum 0.007 and maximum 0.021. The R^2s in the regressions range from 0.755 to 0.791.

The lower panel of table 3 sets out the price and inventory elasticities of demand that are implied by our estimates. We calculate the relevant elasticities for each store-title-month triple and then take averages over the observations in each region and each month since release. We then take an unweighted average over regions to generate our summary data. The average elasticity with respect to price over all months since release is low at -0.134. The average elasticity with respect to inventory is 0.155. As for the main demand results, there is some variation across regions. The standard deviation in price elasticities across regions is 0.081; the minimum value is -0.260 and the maximum is -0.011. The standard deviation in inventory elasticities is 0.034 with a minimum of 0.126 and a maximum of 0.242.

The lower panel of table 3 also documents the variation in elasticities both across months since release of the title and across Box Office categories. There is very little variation over time for the price elasticities.[39] The value in month 3 is -0.139, the minimum is -0.143 and

[37]On one hand, this is a liability of the extremely flexible specification of the model, because the rich set of fixed effects removes variation in price across stores and titles. On the other hand, the fixed effects allow a much better fit of the model and improve our ability to predict retailers' supply choices, which is the primary focus of the paper.

[38]We also exclude this region from the summary statistics and reduced-form analyses.

[39]Since there is only a single price coefficient, variation in elasticities across months and box-office groups

the maximum is -0.127. The variation for inventory elasticities is displayed in Figure 1 of the appendix. They are all positive, as expected, implying that a title with more tapes on the shelf has higher demand than other titles. The inventory elasticity for Box Office A titles is higher than those for other Box Office categories, and for each group the elasticity decreases over time since release.[40]

Finally we regress the estimated store-title quality levels on observable store and title characteristics. Results for the first region are reported in the appendix; those for other regions are similar. The goal is two-fold: first to check that title and store characteristics have the expected signs, and second to demonstrate the inability of these characteristics to explain the majority of variation in the data. The results are intuitive. Box office category A titles have higher estimated quality than those in categories B and (particularly) C. Action/adventure movies and comedies have higher demand than other genres; children's movies, romances and science fiction movies have particularly low rental demand. Markets with a high percent female consumers have high demand for video rentals; those with a high proportion of family heads who are single mothers have particularly high demand and those with a high proportion of family heads who are single without children have particularly low demand. The Blockbuster dummy is positive and significant, probably indicating that Blockbuster chooses to enter high-demand markets.[41] The R^2 on these regressions is only 0.4: even with a very flexible functional form, our observable title and store characteristics are able to explain less than half of the variation in the data.[42]

6 The Supply Side: Moment Inequalities

Having estimated a detailed demand model, the final piece of information needed to analyze retailers' and distributors' choices of contract types is the value (positive or negative) of holding additional tapes. This could include negative effects such as insuring and restocking inventory, as well as valuable effects such as the ability to sell used inventory, and using inventory depth to maintain a long-term customer base and draw new customers into the store. It also includes the effect of an increase in inventory of one title on later rentals of other titles that is not incorporated in the demand model. We allow the effect of additional inventory to differ between titles taken on LP and RS contracts, thereby allowing retailers to respond to unobservable differences between the two contracts or to display organizational inertia in their choice of contract.

We use the method of moments inequalities estimator developed in Pakes, Porter, Ho and Ishii (2007) to estimate the value of holding additional inventory. That paper describes

is generated from variation in the level of demand and price across months and box office categories.

[40]These results are consistent with the idea that consumers who rent new releases (particularly Box Office hits) are influenced by advertising such as window displays and the number of tapes available. Consumers who rent movies after the first month or so since release do not expect as much buzz and are less influenced by these kinds of advertising.

[41]The coefficient on the number of households is negative and significant, implying that large markets where Blockbuster is not located have low demand. The coefficient on median income is negative and significant: wealthier markets have fewer movie rentals, perhaps because wealthy families choose more expensive leisure activities.

[42]This motivates our use of a nested-logit framework, in which we can feasibly include both title and store fixed effects.

how to use inequality constraints to generate conditions that can be used for estimation and inference. The intuition in our application is straightforward: we assume that on average, stores' profits from the observed portfolio of titles and choices of inventory must exceed profits from alternative portfolios and choices of inventory. The estimated demand model predicts the change in the number of rentals caused by changes in inventory holdings, prices and the consumer's choice set that result from a portfolio deviation. This determines the main input to the inequalities analysis: the profit change up to the inventory holding cost.[43]

We derive inequalities from every store's choice of contract for titles that we observe it to take. We include all titles that are taken on RS and LP contracts (for which the store makes decisions at the title level).[44] The first inequality for a particular store-title pair is generated by defining the store's alternative choice as dropping that title. This generates an upper bound on the value of holding inventory. The second inequality defines the store's alternative as adding tapes to the existing inventory for the relevant title. We add 10% of the existing inventory where possible; if this brings total capacity above the maximum quantity restriction we add tapes up to that restriction. This provides a lower bound on the inventory-holding value.[45] We assume that the store has perfect foresight regarding the titles to be released to video in the following five-month period,[46] but that it may imperfectly predict demand for those titles, or the value of holding inventory.

6.1 The Store Profit Equation

Our first step for specifying the moment inequalities is to predict the total return to the store from its contracts with all distributors over the four-year period covered by the data. First, we use the estimated coefficients from the demand model to predict the market share of title j at store m in "month since release" t:

$$s_{jmt}(\hat{\delta}, \hat{\gamma}, \hat{\eta}, \hat{\theta}, \hat{\lambda}, \hat{\alpha}, \hat{\sigma}, \hat{\xi}) = \frac{e^{(\hat{\delta}_j + \hat{\gamma}_j z_m + \hat{\eta}_m + \hat{\theta}_t + \hat{\beta}_t x_j + \hat{\lambda}_t c_{jm} - \hat{\alpha} p_{jmt} + \hat{\xi}_{jmt})/(1-\hat{\sigma})}}{D_{gmt}^{\hat{\sigma}} \left[\sum_{gmt} D_{gmt}^{(1-\hat{\sigma})} \right]} \tag{4}$$

[43] We use the inequalities methodology in preference to a more standard method such as a logit or probit for two reasons. First, logit and probit methods ignore dynamic effects. The inequalities methodology enables us to difference out dynamic effects without generating a bias in estimation because the alternative portfolio choices defined in the inequalities estimator are not required to be optimal for the store. Second, since the store makes choices regarding FLF contracts at the distributor-year level but those regarding RS and LP at the title level, it is not obvious at which level to define the logit or probit estimator.

[44] We exclude titles on FLF contracts because the store makes these decisions at the studio-year level, rather than at the title level. We also exclude sell-through priced titles (for which there is no contract choice) and titles that are in release in our data for less than six months. We do not consider store-title pairs where the store is not observed to take the title. We could generate inequalities where the alternative was to take these titles, but this would require us to predict the unobserved quality ξ_{jmt} (rather than using an estimated value from the demand model), likely adding noise to the estimation.

[45] We choose not to define alternatives by dropping tapes rather than titles because many stores take the minimum inventory per title required by the RS contract.

[46] Titles' theatrical release dates are about five months before their release to video, so store managers observe which titles will be available several months in advance.

where:

$$D_{gmt} = \sum_{k \in J_{gmt}} e^{(\hat{\delta}_k + \hat{\gamma}_k z_m + \hat{\eta}_m + \hat{\theta}_t + \hat{\beta}_t x_k + \hat{\lambda}_t c_{jm} - \hat{\alpha} p_{kmt} + \hat{\xi}_j)/(1-\hat{\sigma})} \tag{5}$$

for J_{gmt} the set of all products in group g held by store m in month t.

Next we aggregate over months and subtract store m's total payment to the distributor for title j. For a title offered under RS and LP contracts, we denote the return r_{jm} as

$$r_{jm}(\cdot) = \begin{cases} \sum_{t_j}^{t_j+4} q_{tjm} p_{tjm} - F_j c & \text{if LP, and} \\ y_j^{RS} \sum_{t_j}^{t_j+4} q_{tjm} p_{tjm} - u_j^{RS} c & \text{if RS} \end{cases} \tag{6}$$

where q_{tjm} is the number of rentals, F_j is the wholesale cost per tape under LP, y_j^{RS} is the portion of revenues kept by the return under RS, and u_j^{RS} is the upfront fee per tape under RS. As before, we consider the first 4 months plus a fifth observation for later months.

The number of rentals may be constrained by the inventory of the title, c_{jm}, and the maximum number of rentals per tape, τ_{jm}.[47] Additional constraints, in the form of minimum and maximum quantity restrictions on inventory purchases, also apply for RS contracts. We denote the constrained inventory as $\tilde{c}_{jm}$.[48] Thus, the quantity actually rented out is given by:

$$\tilde{q}_{jmt} = \min\left(M s_{jmt}(\cdot), \tau_{jm} \tilde{c}_{jm}\right). \tag{7}$$

This implies that the total return to store m from title j, (offered under both RS and LP contracts), is given by:

$$r_{jm}^{obs}(\cdot) = I_{jm}^{LP} \left(\sum_{\tilde{t}=t_j}^{t_j+4} \tilde{q}_{\tilde{t}jm} p_{\tilde{t}jm} - F_j \tilde{c}_{jm} \right) + I_{jm}^{RS} \left(y_j^{RS} \sum_{\tilde{t}=t_j}^{t_j+4} \tilde{q}_{\tilde{t}jm} p_{\tilde{t}jm} - u_j^{RS} \tilde{c}_{jm} \right), \tag{8}$$

where I_{jm}^{LP} and I_{jm}^{RS} indicate the contract chosen by retailer m for title j, and the *obs* superscript denotes "observed" contractual choices.[49]

Given $r_{jm}^{obs}(\cdot)$, we can write the store's profit from all of its titles on the observed contracts as:

$$\begin{aligned} \pi_m^{obs}(\cdot) \;\; = \;\; & \sum_s \sum_{j \in J_s} \left(r_{jm}^{obs}(F, u, y, \bar{c}, \underline{c}, \hat{\delta}, \hat{\gamma}, \hat{\eta}, \hat{\theta}, \hat{\lambda}, \hat{\alpha}, \hat{\sigma}, \hat{\xi}, \tilde{c}, k) - C(x_m, x_j, \mu)\ \tilde{c}_{jm} \right) \\ & + \eta_m + \rho(\tilde{c}_{ms}, k_{ms}) + \varepsilon_{ms}, \end{aligned} \tag{9}$$

where J_s is the set of titles released by distributor s during the time period covered by our data and $C(x_m, x_j, \mu)$ is the cost (positive) or value (negative) of holding a tape. We

[47] We consider τ to be a technology parameter that is not chosen by the store. We define τ to be the 95th percentile of a store's distribution of the number of rentals per tape for titles in the same box-office category and contract type in the same month after release. Thus, we allow for an extremely flexible non-parametric specification of the τ parameter. In principle, however, stores may have some discretion over how intensively to use their inventory (up to the point where a tape physically breaks) and we rule out this source of endogeneity. For a detailed discussion of this issue, see Mortimer (2007).

[48] Thus $\tilde{c}_{jm} = \max\left(\underline{c}_{jm}, \min\left(c_{jm}, \bar{c}_{jm}\right)\right)$.

[49] When a store chooses not to stock a title, we assume it makes no contribution to the store's profit.

estimate $C(\cdot)$ as a reduced-form function of store and title characteristics with parameter vector μ. A store fixed effect is denoted η_m, and $\rho(\tilde{c}_{ms}, k_{ms})$ is the effect of the store's choice of contracts at the end of our four-year sample on subsequent profits.[50] The final term, ε_{ms}, is an unobservable such as store prediction error in demand or in the cost or value of holding inventory.

6.2 The Inequality Estimator

We now demonstrate how inequalities are generated when we allow for two types of deviations from the store's observed choices: dropping a particular title, or adding to the existing inventory of that title.

For example, consider title j' released by distributor s'. Suppose that the store chooses to take the title on a LP contract. We assume that:

$$E\left(\pi_m^{obs}(\cdot) \mid I_m\right) \geq E\left(\pi_m^{altj'}(\cdot) \mid I_m\right), \tag{10}$$

where $\pi_m^{altj'}$ is defined analogously to π_m^{obs} for the alternative portfolio choice (e.g., the store drops title j' and holds all other contracts fixed). The expectation is taken conditional on I_m, the store's information set at the time when it makes its choice. Letting $k_{ms'}^{obs}(j')$ indicate that the j'th element of $k_{ms'}$ is store m's observed contract and $k_{ms'}^{0}(j')$ indicate that the title has been dropped, and assuming that title j' has zero demand by the end of the 4-year sample period (so that both the $\rho(\cdot)$ and η_m terms are differenced out), this implies the following inequality:

$$E\left(\Delta\pi_m^{s',j'}(\cdot) \mid I_m\right) =$$

$$E\{\sum_s [\sum_{j \in J_s} \{\Delta r_{jm}(k_{ms'}^{obs}(j'), k_{ms'}^{0}(j')) - C(.)\ \Delta\tilde{c}_{jm}(k_{ms'}^{obs}(j'), k_{ms'}^{0}(j'))\} + \Delta\varepsilon_{ms'}] \mid I_m\} \geq 0. \tag{11}$$

The difference function $\Delta\tilde{c}_{jm}(k_{ms'}^{obs}(j'), k_{ms'}^{0}(j')) = (\tilde{c}_{jm}^{obs} - \tilde{c}_{jm}^{altj'}) = \tilde{c}_{jm}(k_{ms'}^{obs}(j')) - \tilde{c}_{jm}(k_{ms'}^{0}(j'))$, and similarly for $\Delta r(.)$. The calculation incorporates the revenue from all titles released by all distributors in all years in the data, since changing a single contract may affect demand for other distributors' titles, even if these are released in later months.[51] Each title taken by the store implies a similar 'drop the title' inequality. The second inequality for each title ('add inventory') is generated in an analogous way.

Finally, we take an expectation conditional on the instruments $z_{ms'}$, where s' is the distributor whose titles are switched by the store. We define these instruments such that

[50] The arguments in $\rho(\cdot)$ are as follows: k_{ms} is a vector denoting store m's observed contract type for each title taken from distributor s, and $\tilde{c}_{ms}$ is a similarly defined vector of observed inventory choices. In estimation, we choose alternative portfolios whose end-of-period contracts are the same as those observed in the data. Thus, the $\rho(\tilde{c}_{ms}, k_{ms})$ term, like η_m, is precisely differenced out of our inequalities. This modeling choice may imply that the alternative portfolio used in our inequalities is not the optimal alternative for the store. However, as discussed below, this will not affect the consistency of the estimates.

[51] The demand framework allows a change in contract for title j to affect the within-group share and therefore demand for title k in all months where they overlap in consumers' choice sets. We assume that title k's demand in months before j is released is unaffected by a change in j's contract type, implying that consumers do not predict this change. If title k is active after title j has left the dataset, we assume that its demand in these later months is unaffected by j's contract change.

$z_{ms'} \subset I_m$ and $E(\varepsilon_{ms'} \mid z_{ms'}) = 0$. This together with equation (11) implies that:

$$E(\Delta\pi_m^{s',j'}(\cdot) \mid z_{ms'}) = E\left\{\sum_s \sum_{j \in J_s} \left(\Delta r_{jm}^{s',j'}(\cdot) - C(x_m, x_j, \mu)\ \Delta\tilde{c}_{jm}^{s',j'}(\cdot)\right) \mid z_{ms'}\right\} \quad (12)$$

$$= E\left\{\Delta r_m^{s',j'}(\cdot) - C(.)\Delta\tilde{c}_m^{s',j'}(\cdot) \mid z_{ms'}\right\} \geq 0 \quad (13)$$

where $\Delta r_m^{s',j'}$ is the sum of $\Delta r_{jm}^{s',j'}$ over all titles, and the change in the total store-level value of holding inventory for a particular deviation is written as:

$$C(.)\ \Delta\tilde{c}_m^{s',j'}(\cdot) = \sum_s \sum_{j \in J_s} C(x_m, x_j, \mu)\ \Delta\tilde{c}_{jm}^{s',j'}(\cdot).$$

We use predicted values of several inputs to the profit equation for both observed and alternative portfolios: the constrained inventory $\tilde{c}_{jm}$, prices p_{jtm} and technology (rentals per tape) τ_{jm}. Our assumptions are as follows. We note that prices vary only slightly between titles within a store.[52] We therefore do not directly model a price change after the change in portfolio. Instead we use the average price for each month for the particular store-box office category-contract type-month combination being considered.[53] Similarly, we do not formally model the firm's choice of $\tilde{c}_{jm}$ and τ_{jm} for every title. We define τ_{jm} as the 95th percentile of the distribution of τ observed for titles in the same store-box office category-contract type and for $\tilde{c}_{jm}$ we use the same average used as in expected demand.[54,55]

Finally we convert the expectations in equation (12) into sample averages across stores.[56]

[52] The average within-store price of an A title is \$2.88 for RS contracts and \$2.84 for LP. The equivalent prices for B titles are \$2.79 and \$2.80; those for C titles are \$2.73 and \$2.73 respectively.

[53] We use this average because there is less variation within-store across titles than there is across stores for a particular title (see Mortimer (2007) for evidence on this). We could have considered titles in the same store-genre-box office category-contract type-month, consistent with the nest definitions in the demand model, but encountered problems with small sample sizes in some cases. Consistent with the assumptions in the demand model, we exclude store-title-month triples with zero transactions.

[54] In the second ('add inventory') inequalities, increasing the inventory of a particular title could force the store to hold a total storewide inventory level higher than our definition of its maximum capacity (110% of that observed for the store in any month in the data). In this case we assume that the store's inventory equals that maximum cutoff, provided it implies an inventory level for the relevant title that is above its observed inventory; otherwise no inequality is generated.

[55] In a few cases, the store-box-contract group is empty, so we cannot get predicted inventory from this method. In such cases, we use the minimum number of tapes required by the distributor as the expected inventory level for RS titles. For LP titles, we use the average number of tapes per LP title taken by the store for titles in neighboring box office categories. Remaining missing values for LP contracts are filled in using $\frac{1}{3}$ of the minimum quantity required under RS for the same title: this is the industry rule of thumb for the number of tapes taken under LP. We predict price and τ_{jm} in the case where the store-box-contract group is empty using other contract types. Prices for titles taken on LP contracts are defined as the maximum of the average prices in the same store-box group under RS, FLF and sell-through priced contracts; those for titles taken on RS contracts are the average of the average prices under the other three contract types. Finally, in all these cases we define maximum τ as the maximum of the maximum τ's under the other three contract types. If any of these values are still missing we use the average price or maximum τ in the store-contract type for titles in neighboring box office groups or the average price in the store-contract type-box office category for neighboring months.

[56] We stack the inequalities for all regions before taking the average over stores. We therefore estimate a

We also average over alternative choices j' in a particular distributor-year before interacting with the instruments. Considering first the 'drop the title' inequalities, this implies the following equation for estimation:

$$\Delta\bar{\pi}_{ys'} = \frac{1}{M}\sum_{m}\left((r_m^{obs} - C(.)\ \tilde{c}_m^{obs}) - \frac{1}{Q_{ys'}}\sum_{j'\in(s',y)} (r_m^{altj'} - C(.)\ \tilde{c}_m^{altj'}) \right) \otimes g(z_{ms'}) \geq 0 \quad (14)$$

where y indexes years, s' indexes distributors, $Q_{ys'}$ is the number of titles released by distributor s' in year y, $g(.)$ is any positive-valued function of the instruments and M is the number of stores in the data. We therefore have one moment per distributor-year-instrument triple. We exclude distributor-years where no titles are released and average within each year (before taking the store average) over distributors that release fewer than five titles during our panel. This generates 56 distributor-year moments per instrument. Our methodology is analogous for the 'add inventory' inequalities, again generating 56 distributor-year moments per instrument. The identified set of parameter values is the set of parameters that satisfy the implied system of inequalities. If there are no feasible parameters we use a method of moments methodology, minimizing the Euclidean distance by which the inequalities are violated.

The instruments $z_{ms'}$ (defined at the store-distributor level) are required to be uncorrelated with $\varepsilon_{ms'}$.[57] The term $\varepsilon_{ms'}$ includes store prediction error on: revenues, the value of holding inventory, the value of used tapes, and any other unforseeable costs to the store from altering its contracts with distributor s'. The error term may also contain econometrician measurement error. We assume that the error does not contain unobservables that differ across contract types and that affect store choices; we rely on the flexible specification of the inventory-holding value to capture such effects. Our instruments are a constant and indicators for the size of the store's chain. These are known to the store when it makes its choices and perfectly observed by the econometrician and are therefore uncorrelated with the error term. They are likely to be correlated with retailers' portfolio and inventory choices, for example because market size, the percent urban/suburban, and average education levels differ across the markets where different-sized chains locate.[58]

6.3 Results

We define several specifications for the value or cost of holding a tape including different combinations of the following variables: a constant, indicators for Box Office category B and C titles, indicators for small and large retailers, and indicators for retailers from small and large chains.[59] We also include an indicator for titles taken on LP contracts and interactions

single set of costs for all stores, taking into account all of the region-specific demand estimates from Section 6.

[57]They must also be positive to ensure that no inequalities are reversed by the interaction with $z_{mz'}$.

[58]Less finely-measured chain size dummies are included explicitly in the cost equation to account for any potential volume discounts. We only find substantial differences between stand-alone stores and chains of two or more outlets.

[59]Small chains are those containing 2-44 stores, large chains have 112-1652 stores and chains with a single store are the excluded category. Small stores are in tiers 4-6, large stores are in tiers 7-10 and those in tiers

between this and the other variables. This allows stores to have different preferences for different contract types. The results are given in Table 4. The estimate of μ was a singleton for every specification: that is, there was no parameter vector that satisfied all the inequality constraints. As noted in Pakes, Porter, Ho and Ishii (2007), this does not imply that we should reject the specification. The result is very likely to be caused by the random disturbances in the inequalities. The probability that all the inequalities will be satisfied can be made arbitrarily small by increasing the number of inequality restrictions.[60] We report the conservative 95% confidence intervals derived in Pakes, Porter, Ho and Ishii (2007).

The first specification in table 4 includes a constant and indicators for medium and large chain sizes, for medium and large retailer sizes and for titles taken on LP contracts. All the coefficients are significant at p=0.05. The constant term is positive; all the rest are negative, implying that larger stores and chains have a lower cost (or a higher value) per tape, and that stores perceive a larger value of taking LP contracts compared to RS contracts. Specification 2 adds interactions between the LP indicator and the store tier and chain size indicators. The non-interacted store characteristics then become insignificant so Specification 3 drops them and includes instead indicators for titles in Box Office B and C categories. Finally, Specification 4 adds interactions between the LP indicator and these Box B and Box C indicator variables. We use this final specification as the input to our counterfactual simulations because it provides a richer level of detail than the others.

Table 5 translates the estimates from Specification 4 into the implied cost per tape for each type of retailer and each type of title. Negative numbers indicate value to the store. Two findings emerge from table 5. First, most of the estimates are negative, implying that stores generate a positive value from holding tapes that is not captured in the rest of our model. For RS titles, the values are \$2.66 per tape for box A titles, essentially zero for box B titles and \$10.65 per tape for box C titles. There are several reasons why additional tapes may be valuable to the store. For example, the store generates approximately \$9 of revenues from selling each used tape. Unobserved volume discounts or negotiated deals could reduce the cost to the store of taking tapes compared to the cost used in our analysis. In addition, adding tapes to the shelf may increase retailer profits by attracting new consumers to the store or avoiding stockouts. C titles may be particularly valuable because they are often niche or "arthouse" titles that appeal to a particular segment of the population and therefore may attract more customers from the store's competitors than more mainstream movies. For all of these reasons the small estimated value to the store of holding RS inventory seems quite reasonable.

The second finding is that most retailers (all but the stand-alone outlets) have a much higher value per tape for LP titles than for RS titles. We have two hypotheses that could explain this finding. First, chains may make more money from LP than from RS because they are able to negotiate volume discounts on LP titles (beyond the 20% discount already incorporated into our model) or because they keep a higher proportion of the revenue from selling used tapes under LP. Stand-alone outlets may not have sufficient volume to negotiate discounts and may have trouble generating demand for their used tapes. Alternatively, chains

1-3 are the excluded category.

[60] In fact most of the inequalities are close to being satisfied. In our preferred specification a median of 170 stores (out of a total of 6393) violate each moment inequality and the median amount by which these stores violate the moment is only \$9.16.

may have deeper relationships with LP wholesalers that make them inclined to take more titles on LP contracts. For example, unobserved promotional activities and other attention from LP wholesalers might influence the contract choices of chains. Stand-alone outlets would be unlikely to receive this attention; they may also have credit constraints with LP wholesalers that push them towards taking RS titles. We cannot distinguish between these hypotheses within the inequalities framework. The counterfactual analyses below provide some information on the extent to which these alternative explanations may apply.

7 Analysis of the Use and Impact of Full-line Forcing Contracts

Our goal in the final stage of the analysis is to analyze the profitability of retailers' and distributors' contracting choices. We ask whether the distributors that choose to offer FLF contracts make more money than they would otherwise, and whether the non-FLF distributors would lose money by offering FLF terms. Finally, we examine whether retailers on average made profitable choices.

The parameters estimated in our demand and supply models allow us to predict retailer choices and profits for both retailers and distributors. We focus our analysis on six large distributors during a 12-month period of our panel (months 30-41), and the model's predicted outcomes when FLF is either offered or not. We focus on months 30-41 in order to allow some time for learning about the new contract type, and a 12-month period to correspond to the length of FLF contracts used in the industry. The six distributors that we consider are among the nine large distributors described in section 3 that offer some type of sharing contract (RS and/or FLF). Two of the six offer FLF terms.[61]

For each focal distributor, we would ideally simulate the dynamic decision-making process of each retailer,[62] considering all possible combinations of titles and contract types from all distributors over the 12-month period analyzed. However, this is computationally infeasible because of the large number of titles available in each year. Instead we approximate the dynamic process using a three-stage model.[63] First we predict retailer and distributor profits under the assumption that the retailer takes the FLF contract from the relevant distributor holding all other retailers' choices fixed (this is our counterfactual for non-FLF distributors and our observed scenario for FLF distributors). Second, we predict the retailer's choices if FLF is not available. This is the more complex step since an ordering decision in one month affects demand for titles and therefore ordering decisions in all future months. We make the simplifying assumption that retailers' orders only take into account titles that are available in the current month (those that are released within the previous four months or

[61]Of the remaining three distributors, two offered FLF contracts shortly after the period we analyze; the last, also a FLF distributor, exited the market at the beginning of our period of analysis.

[62]For each distributor, we analyze the decisions of all retailers that are active from months 30-41 and that either do not take a FLF contract or take FLF and are compliant with the contract. We define compliance as taking at least (N-2) titles during the year, where N is the number of titles released by the FLF distributor. This allows retailers to refuse to take a few titles due to objectionable content, but excludes retailers that participate in a trial period and then switch away from FLF. Retailers cannot choose contract types that are not offered for the relevant title.

[63]For example, the full dynamic model would require us to evaluate 1.20e+29 different possible outcomes for the first FLF distributor in our data. The three-stage model requires evaluation of 647801 combinations which takes approximately 16 hours of computer time.

in the current month). That is, stores make a static choice by considering static first-month profits.[64] Our assumption that each store operates in a separate market implies a unique equilibrium.[65] The third step is to allow each retailer to choose the more profitable option: the FLF contract or the non-FLF portfolio chosen in the static model.[66]

We hold fixed retailers' choices of contract types both before and after the counterfactual. In a static model choices made in month t do not anticipate contracts available in month $t+1$ so the first assumption is reasonable. The second assumption implies that the distributor chooses to implement (or remove) the FLF contract for just a single period (a single year). We simplify by assuming, as we do in the moment inequalities analysis, that inventory and rental price are determined by contract type (the average in the data for the store-box-contract type-month). We define the unobserved quality of newly-taken titles to be the 25th percentile in the store-box-genre group. The contract terms of any alternative contracts are determined using the modal values over all stores for that contract type and title.[67]

7.1 Interpreting the Relative Value of LP Contracts

We first consider to what extent the incremental inventory-holding value associated with LP contracts affects retailers' bottom-line profits. To the extent that they affect retailer's bottom-line profits, they should be taken into account in the model when the retailer chooses between the FLF contract and its alternative. To the extent that they do not affect bottom-line profits, we assume that they capture a reluctance to use RS contracts specifically rather than sharing contracts in general. Under this assumption we can identify the incremental inventory-holding value of LP titles that affects retailers' profits by comparing data on FLF take-up with the model's predictions when different proportions of this value are assumed to affect retailers' bottom-lines. We then rely on this proportion of the value of holding inventory for LP titles when calculating counterfactual retailer profits in section 7.2.

[64] On average approximately 20% of the average title's revenues are realised within the first month.

[65] In order to make the analysis feasible we assume that, when the retailer takes a FLF contract from a non-FLF focal distributor, it can only drop titles from other distributors that are the most negatively affected in terms of revenues at the 25th percentile. When the retailer re-optimizes without a FLF contract from a FLF focal studio we assume that it does not take titles that have revenue below the top 25th percentile of all its titles. We also adapt the way costs are handled in this myopic counterfactual. We assume that the costs and values estimated in the inequalities analysis, and the upfront fees for all contract types, are amortized over the life time of the title proportionate to the average percent of the title's lifetime rentals that occur in the first month. This average is across all same-tier stores and all same-box office group titles taken on the same contract type. The store takes only the first month's portion of costs into account when making its static choices.

[66] We conduct a robustness test of the static model by comparing the results to those from a dynamic model where each retailer accounts for all future demand effects and interactions between titles when choosing its portfolio. Here we consider just the three-month period between months 30 and 32. We add the following simplifying assumption to the dynamic model: when the retailer re-optimizes without a FLF contract from the focal studio we assume that it does not take titles that are taken in the observed data by fewer than 10% of same-tier retailers. Under these assumptions the static and dynamic models have very similar predictions for the set of titles and contract types chosen by stores.

[67] In fact they are constrained by Section 2 of the Clayton Act to be the same for all stores for a particular title. We take a modal value because a small number of stores negotiate special deals such as volume discounts with particular distributors. These are classed as second-degree price discrimination and are therefore not illegal. We assume that stores do not expect to be able to negotiate such deals for alternative contracts.

Table 6 has seven panels that relate to the six distributors considered in detail in the simulations. The first FLF distributor has two panels relating to the 294 (1574) retailers that choose to take (not to take) the FLF contract in reality. For the second FLF distributor, nearly all retailers choose to accept FLF terms. Thus, this distributor has just one panel relating to 2094 retailers, all of which took the FLF contract.[68] Four additional panels relate to each of the non-FLF distributors, and analyze all 2316 retailers active during this period.[69] Within each panel, the first row lists the observed portfolio choices while the second and third rows report predicted choices when FLF is, or is not, an option.

The first column of Table 6 reports the average number of titles taken on each contract type, assuming that 100% of the incremental LP inventory-holding value applies to retailers' bottom-lines. The model does a reasonably good job predicting retailers' portfolio and contract choices for the first two non-FLF studios. The fit is not as good for non-FLF studios 3 and 4: the model over-predicts RS take-up for non-FLF studio 3 and over-predicts the number of titles not taken for non-FLF studio 4.[70] For FLF studios, the relevant comparison is between the observed store portfolios and those predicted when FLF is an option for retailers. In this case, the fit of Model 1 is less good: while the ratio of LP to RS titles is often reasonable and the fit for retailers that choose not to take the FLF contract is very good, the model substantially under-predicts FLF takeup.

The second column of Table 6 assumes that none of the estimated incremental LP inventory-holding value affects retailers' profits, implying that none are taken into account when retailers compare their profits from taking and rejecting the FLF contract. Not surprisingly, this model predicts much more FLF takeup for all stores. This improves the fit of the model for retailers that choose to take a FLF contract from a FLF distributor. However, it reduces the fit substantially for the 1574 retailers that do not choose to take the FLF contract from the first FLF distributor: now 9 titles out of 18, on average, are predicted to be taken on FLF terms compared to 0 in the observed data.

The third column applies a percentage of the incremental LP inventory-holding value to retailers' bottom-lines that minimizes the sum of squared differences between observed and predicted choices.[71] The estimated fraction is 44%.[72] This model predicts the data quite well. In particular, for the first FLF distributor, we now see a separation between the retailers that choose not to take a FLF contract (predicting on average 3.0 out of 18 titles for FLF) and those that take the FLF contract (on average 7.9 out of 11.6 titles).[73] The fit

[68]Only 35 retailers choose not to take FLF from this studio, a sample too small to analyze.

[69]The total number of retailers considered for each FLF distributor is less than 2316 because some retailers are non-compliant, engaging in short trial periods of FLF that we do not attempt to analyze.

[70]We do not expect the model to fit the data perfectly for every distributor and every year considered separately, because the inequality estimates are averages across all distributors, retailers and months in the data.

[71]An observation is a retailer-FLF distributor pair.

[72]For example, stores in tiers 7-10 that are members of large chains are predicted by the inequalities analysis to have a value per tape of \$2.66 for RS titles from Box office group A and a value of \$48.30 per tape for LP box A titles. Applying 44% of the LP terms implies that \$22.75 of this is associated with a unobserved dollar value of LP while the remaining \$25.55 is inertia that does not directly affect retailers' profits. Some of the value that is not affiliated with a direct dollar value may also affect retailers' decisions regarding FLF take-up. That is, in fact we are estimating an upper bound on the proportion that affects bottom-line profits.

[73]The observed average number of titles taken on FLF by FLF retailers is less than the total number of

is also good for the second FLF studio: we predict on average 3.9 out of 5.3 titles.

7.2 Results: Profitability of Retailer and Distributor Choices

Table 7 predicts the profitability of retailer and distributor choices under Model 3. The first column of Table 7 displays average retailer profits, the second sets out average profits per retailer for the focal distributor (the distributor whose choices we analyze) and the third reports average total profits per retailer for all other distributors. Each panel relates to different focal distributors, and reports average profits when FLF is and is not offered by the focal studio.

Consider first the non-FLF distributors in the bottom four panels. In each case we find, as expected, that retailers have higher average predicted profits when given the additional option of taking a FLF contract. The profits of non-focal distributors differ very little across the two scenarios. Predicted FLF take-up, set out in Table 6, is relatively high for these distributors. However, the second column of Table 7 shows that the predicted profits of the focal distributor are higher in the "no FLF" scenario. That is, non-FLF distributors seem to be making profit-maximizing choices regarding whether to offer FLF contracts. There are two reasons why FLF is unprofitable for these distributors, both of which can be seen from the last column of Table 6. First, several non-FLF distributors have relatively high predicted retailer take-up of titles without offering a FLF contract, so there is little change in the number of titles taken when they offer FLF terms. Second, retailers often switch a large proportion of titles from LP to FLF contracts, implying a large reduction in the upfront fees collected by the distributor. We conclude that these distributors are relatively strong players in the market, producing attractive titles that most retailers already take on LP or RS contracts. These distributors lose money when they also offer more generous FLF terms.

The picture is different for FLF distributors. Again we find that retailers' average profits increase when they are given the option of taking the FLF contract, and that other studios are affected very little by the focal studio's choice. However, FLF distributors are predicted to make money from offering FLF contracts. The reason is simple for the second FLF distributor, FLF terms generate a large increase in retailer take-up of the six titles released during the year (from an average of 2.6 to 4.5 titles per retailer). That is, this less strong distributor gains substantially from offering generous terms to induce stores to carry all of its titles.

The story is slightly different for the first FLF distributor. This distributor makes positive profits from FLF take-up by the set of stores that are observed in the data to take the FLF contract ("FLF stores"), but negative profits from FLF take-up by "non-FLF stores." The reason is again clear from Table 6: FLF stores have a bigger increase in overall take-up when they take the FLF contract than do non-FLF stores. Most non-FLF stores that are predicted to take the FLF contract are taking the majority of titles from the distributor already. Furthermore, the distributor may be able to predict which stores take the FLF contract and which do not, for two reasons. First, FLF take-up is fairly well-predicted by the model, and second, FLF stores differ from other retailers on observable dimensions. For example, FLF stores are less likely to compete with a local Blockbuster outlet than

titles released during the year primarily because some stores may have started their FLF contract part-way through the year.

non-FLF stores (19% versus 27%). Non-FLF stores may therefore have adopted a strategy of "breadth" rather than "depth" to differentiate themselves from their competition. FLF stores are also disproportionately members of middle-sized chains: none are single-outlet stores, and none are in the "large chain size" defined in the inequalities analysis. Finally, 49% of non-FLF stores are in the bottom quartile of take-up for RS contracts in our data; no FLF stores are in this bottom quartile. This may be indicative that non-FLF stores have poor relations with Rentrak or some other friction that prompts them to choose LP contracts when possible.

8 Conclusion

We study the decisions of distributors and retailers to adopt bundling (FLF) arrangements within a supply-chain setting using data from the video rental industry. Our results indicate that distributors are making optimal choices regarding whether to offer FLF contracts. Those that choose not to offer these contract terms tend to be relatively strong players that are producing popular titles during this period; they do not need to offer more attractive terms to persuade retailers to carry their movies. Of the two FLF distributors we analyze, one is a less strong player during this period. The other is an intermediate player, for which FLF take-up is profitable only for some retailers, which differ in observable ways from other retail outlets.

Content providers make or lose money based on the quality of their content, which is constantly refreshed in markets for information goods. Thus, an important advantage for any study of bundling is the availability of detailed data on both the consumption of this content, and the supply-side features of the market. Such data have often not been available in markets for which bundling is an important contractual tool, although the potential for gathering such data continues to improve, particularly in digital media markets.[74] We observe this type of detailed data in a market that pre-dates many of the current digital technologies, but still retains many of the salient features of markets for information goods (e.g., low costs of reproduction, and continual update of content). The empirical approach can serve as a model for how to utilize detailed demand and supply data in order to understand the decisions of firms to use bundling contracts, and the implications of their use for policy-relevant questions.

[74]For example, many book publishers engage in various forms of bundling between print and electronic books, and also track downloads directly. Similarly, music downloading services such as iTunes track consumption behavior directly, and employ a variety of contractual arrangements with music labels that govern distribution. As various markets for television shows and movies continue to become more digitalized, they will also gain the ability to track consumption behavior at a more detailed level.

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Table 1: Summary Statistics

Contract	Linear Pricing	Revenue Sharing	Full-Line Forcing	Sell-Through Pricing
Avg. Upfront Cost	66.82	8.46	3.61	15.16
	(5.62)	(1.08)	(1.21)	(1.64)
Avg. Retailer's Share of Revenue	100%	46.01%	59.02%	100%
	(-)	(3.03%)	(1.99%)	(-)
Avg. Minimum quantity	-	10.40	10.96	-
	(-)	(11.70)	(10.74)	(-)
Avg. Maximum quantity	-	23.63	22.84	-
	(-)	(22.74)	(21.85)	(-)
Avg No. of Rentals				
Month 1:	53.90	68.11	53.87	95.92
	(87.59)	(101.59)	(93.78)	(135.27)
Month 2:	70.22	69.73	64.75	88.89
	(99.70)	(99.91)	(87.92)	(108.81)
Month 3:	41.95	34.76	34.61	41.87
	(56.79)	(48.47)	(47.06)	(50.51)
Month 4:	27.10	21.80	22.07	23.47
	(35.00)	(29.16)	(29.49)	(27.53)
Month 5+:	74.57	59.72	60.57	83.58
	(113.75)	(88.85)	(89.01)	(147.01)
Avg Rental Price				
Month 1:	2.65	2.67	2.69	2.68
	(0.57)	(0.49)	(0.60)	(0.54)
Month 2:	2.82	2.77	2.88	2.86
	(0.56)	(0.50)	(0.56)	(0.59)
Month 3:	2.83	2.78	2.87	2.94
	(0.61)	(0.55)	(0.64)	(0.72)
Month 4:	2.83	2.78	2.87	2.95
	(0.66)	(0.60)	(0.68)	(0.83)
Month 5+:	2.80	2.69	2.89	2.96
	(0.72)	(0.67)	(0.75)	(0.88)
Avg Rentals per Tape				
Month 1:	5.61	4.29	4.11	5.14
	(4.39)	(2.88)	(3.14)	(4.66)
Month 2:	7.72	4.76	5.54	5.22
	(4.97)	(3.20)	(3.83)	(3.70)
Month 3:	5.08	2.52	3.46	2.64
	(3.82)	(1.88)	(2.90)	(2.14)
Month 4:	3.58	1.66	2.50	1.64
	(2.97)	(1.33)	(2.45)	(1.67)
Month 5+:	13.59	5.05	7.34	6.91
	(14.45)	(4.97)	(9.10)	(8.95)
Avg Inventory	9.33	14.37	12.95	18.65
	(14.92)	(17.45)	(18.05)	(22.68)

Notes: Averages are across store-title pairs. Month 5+ is average for all months after month 4. Standard deviations in parentheses.

Table 2: Summary Statistics (Cont.)

Contract	Linear Pricing	Revenue Sharing	Full-Line Forcing	Sell-Through Pricing
Total No. of Titles Released by Distributors				
Year 1:	219	115	0	27
Year 2:	204	125	10	24
Year 3:	231	132	18	21
Year 4:	209	113	38	26
Number of Stores	6,358	6,150	5,111	6,171
Avg No. of Titles Taken by Stores				
Year 1:	99.72	23.74	-	20.41
	(44.18)	(24.83)	-	(6.78)
Year 2:	69.64	20.31	4.15	15.24
	(45.03)	(21.69)	(3.15)	(7.89)
Year 3:	98.98	18.61	6.29	14.70
	(56.36)	(23.28)	(3.90)	(6.77)
Year 4:	88.77	14.26	10.36	18.14
	(40.12)	(17.57)	(7.26)	(7.16)

Notes: Total number of titles offered by distributors under each contract type and average number of titles of each contract type taken by all active stores in each year. Standard deviations in parentheses. Titles for distributors may be counted in more than one column. All Revenue-Sharing and Full-Line Forcing titles are also offered under Linear-Pricing contracts, although many titles are offered under LP terms only. No Sell-Through Pricing titles are offered under alternate contracts.

Table 3: Demand Results and Elasticity Estimates

	OLS Coef (S.E.)	IV 1 Coef (S.E.)	IV 2 Coef (S.E.)
Price	-0.027 (0.002)	-0.026 (0.003)	-0.024 (0.003)
Month 2	0.132 (0.023)	0.155 (0.024)	0.139 (0.025)
Month 3	-0.136 (0.022)	-0.191 (0.025)	-0.206 (0.025)
Month 4	-0.399 (0.023)	-0.505 (0.025)	-0.512 (0.026)
Month 5+	0.190 (0.024)	0.276 (0.027)	0.283 (0.027)
Inventory	0.019 (0.0003)	0.021 (0.0004)	0.016 (0.0005)
Inv*Month 2	-0.003 (0.0004)	-0.004 (0.0005)	-0.003 (0.0005)
Inv*Month 3	-0.008 (0.0004)	-0.009 (0.0005)	-0.008 (0.0005)
Inv*Month 4	-0.012 (0.0004)	-0.013 (0.0005)	-0.013 (0.0005)
Inv*Month 5	-0.011 (0.0004)	-0.013 (0.0005)	-0.014 (0.0005)
σ	0.632 (0.0018)	0.498 (0.0030)	0.501 (0.0031)
N	407,006	407,006	407,006
R^2	0.82	0.76	0.76

	Month 1	Month 2	Month 3	Month 4	Month 5
All Box Office categories:					
Price elasticity	-0.127	-0.132	-0.139	-0.143	-0.129
Inventory elasticity	0.269	0.224	0.151	0.090	0.058
Box Office Category A:					
Price elasticity	-0.125	-0.132	-0.142	-0.148	-0.138
Inventory elasticity	0.521	0.437	0.294	0.176	0.123
Box Office Category B:					
Price elasticity	-0.125	-0.127	-0.136	-0.140	-0.128
Inventory elasticity	0.234	0.188	0.128	0.078	0.052
Box Office Category C:					
Price elasticity	-0.129	-0.135	-0.139	-0.141	-0.123
Inventory elasticity	0.106	0.089	0.059	0.035	0.022

Notes: In the top panel, IV1 results instrument for the within-group share only; IV2 instruments for within-group share and inventory (region 1). All specifications include title and store fixed effects, interactions between title fixed effects and store characteristics (the percent with kids, the percent single and the percent white) and interactions between month fixed effects and title characteristics (box office category, genre, rating and interactions of these variables). In the bottom panel, demand elasticities with respect to price and inventory are calculated for every store-title-month observation and then averages are taken within each zipcode region - month, and then across regions.

Table 4: Inequalities Analysis Results

	Specification 1		Specification 2		Specification 3		Specification 4	
	Coef	95% CI	Coef	95% CI	Coef	95% CI	Coef	95% CI
Per Tape:								
Constant	14.38**	[13.10, 15.48]	-3.85**	[-5.18, -2.44]	-2.66**	[-2.98, -2.39]	-2.66**	[-3.02, -2.14]
Box B title					5.07**	[4.26, 5.93]	3.14**	[1.18, 5.46]
Box C title					-7.97**	[-8.36, -7.64]	-7.99**	[-8.72, -7.51]
Medium Chain Size	-5.30**	[-6.75, -4.00]	-0.25	[-2.22, 1.74]				
Large Chain Size	-5.42**	[-6.64, -4.24]	1.01	[-0.73, 3.04]				
Store tiers 4-6	-12.08**	[-13.23, -10.72]	0.17	[-1.14, 1.22]				
Store tiers 7-10	-34.55**	[-35.68, -33.41]	2.12	[-1.82, 4.77]				
Linear Pricing	-35.80**	[-36.25, -35.42]	40.89**	[33.42, 49.17]	11.71**	[7.21, 16.35]	12.14**	[7.31, 17.78]
LP*Box B title							2.65	[-0.19, 4.99]
LP*Box C title							0.04	[-0.67, 0.93]
LP*Medium Chain			-53.92**	[-62.57, -46.33]	-46.50**	[-51.80, -41.74]	-46.47**	[-52.90, -41.63]
LP*Large Chain			-61.14**	[-70.00, -53.43]	-51.43**	[-55.65, -47.29]	-51.38**	[-57.31, -47.07]
LP*Tiers 4-6			-16.17**	[-17.98, -13.48]	2.23**	[0.24, 4.41]	1.57	[-0.08, 4.08]
LP*Tiers 7-10			-44.17**	[-46.83, -39.84]	-6.00**	[-8.06, -3.66]	-6.41**	[-8.17, -3.89]

Notes: In Table 4, coefficients represent predicted costs to the store per tape. "Box B title" and "Box C title" are indicators for titles in Box Office categories B and C: those with theatrical box office revenues \$15-40 million and under \$15 million respectively. "Medium Chain Size" and "Large Chain Size" are stores in chains containing 2-44 stores and 112-1652 stores respectively. Store tiers rank stores by size, where 1 is smallest and 10 is largest. "Linear Pricing" is an indicator for store-title pairs where the title is taken on a LP contract. **: significant at p=0.05; *: significant at p=0.10.

Table 5: Implications of Inequalities Analysis for Costs Per Tape, by Store and Title Type

Retailer Characteristics		% of stores	Box A titles		Box B titles		Box C titles	
			LP titles	RS titles	LP titles	RS titles	LP titles	RS titles
Chain Size:	Tier Size:							
Small	1-3	16.8%	9.48	-2.66	15.27	0.48	1.53	-10.65
	4-6	3.9%	11.05	-2.66	16.84	0.48	3.10	-10.65
	7-10	0.4%	3.07	-2.66	8.86	0.48	-4.88	-10.65
Medium	1-3	18.9%	-36.99	-2.66	-31.20	0.48	-44.95	-10.65
	4-6	16.2%	-35.42	-2.66	-29.63	0.48	-43.38	-10.65
	7-10	6.4%	-43.40	-2.66	-37.61	0.48	-51.35	-10.65
Large	1-3	13.5%	-41.90	-2.66	-36.11	0.48	-49.85	-10.65
	4-6	18.1%	-40.33	-2.66	-34.54	0.48	-48.28	-10.65
	7-10	5.9%	-48.30	-2.66	-42.51	0.48	-56.26	-10.65

Notes: Implications of the estimates in Table 4 for costs (in $ per tape) to each type of retailer of each type of title. "Box B title" and "Box C title" are titles in Box Office categories B and C: those with theatrical box office revenues $15-40 million and under $15 million respectively. "Medium Chain Size" and "Large Chain Size" are stores in chains containing 2-44 stores and 112-1652 stores respectively. Store tiers rank stores by size, where 1 is smallest and 10 is largest. "Linear Pricing" is an indicator for store-title pairs where the title is taken on a LP contract. Positive numbers represent positive costs to the store.

Table 6: Average Predicted Retailer Choices of Titles by Contract Type

	No. of stores	Model 1: All costs Focal studio titles None/LP/RS/FLF	Model 2: No LP costs Focal studio titles None/LP/RS/FLF	Model 3: 44% LP costs Focal studio titles None/LP/RS/FLF
I. FLF studio 1				
i. FLF stores				
observed	294	1.3 / 4.2 / 0.9 / 11.6		
model (no FLF)		4.1 / 11.1 / 2.8 / 0	4.1 / 11.1 / 2.8 / 0	4.1 / 11.1 / 2.8 / 0
model (with FLF)		4.0 / 10.9 / 2.6 / 0.4	1.8 / 4.9 / 1.1 / 10.3	2.3 / 6.4 / 1.4 / 7.9
ii. non-FLF stores				
observed	1574	3.7 / 11.9 / 2.4 / 0		
model (no FLF)		4.7 / 10.1 / 3.2 / 0	4.7 / 10.1 / 3.2 / 0	4.7 / 10.1 / 3.2 / 0
model (with FLF)		4.6 / 10.0 / 3.0 / 0.4	2.6 / 5.3 / 1.1 / 9.0	4.0 / 8.7 / 2.4 / 3.0
II. FLF studio 2				
i. FLF stores				
observed	2094	0.7 / 0 / 0.0 / 5.3		
model (no FLF)		3.4 / 2.6 / 0.0 / 0	3.4 / 2.6 / 0.0 / 0	3.4 / 2.6 / 0.0 / 0
model (with FLF)		2.2 / 1.6 / 0.0 / 2.2	1.2 / 0.3 / 0.0 / 4.5	1.5 / 0.6 / 0.0 / 3.9
III. Non-FLF studio 1				
observed	2316	6.6 / 10.0 / 4.4 / 0		
model (no FLF)		5.4 / 13.8 / 1.8 / 0	5.4 / 13.8 / 1.8 / 0	5.4 / 13.8 / 1.8 / 0
model (with FLF)		5.2 / 13.2 / 1.6 / 1.0	1.4 / 2.9 / 0.3 / 16.5	3.0 / 6.6 / 0.7 / 10.7
IV. Non-FLF studio 2				
observed	2316	1.2 / 6.9 / 1.9 / 0		
model (no FLF)		3.9 / 5.6 / 0.5 / 0	3.9 / 5.6 / 0.5 / 0	3.9 / 5.6 / 0.5 / 0
model (with FLF)		3.7 / 5.4 / 0.5 / 0.5	1.8 / 1.6 / 0.2 / 6.3	2.8 / 3.4 / 0.4 / 3.4
V. Non-FLF studio 3				
observed	2316	8.2 / 9.1 / 1.7 / 0		
model (no FLF)		2.8 / 6.8 / 9.4 / 0	2.8 / 6.8 / 9.4 / 0	2.8 / 6.8 / 9.4 / 0
model (with FLF)		2.3 / 5.4 / 6.7 / 4.5	0.5 / 0.6 / 0.7 / 17.3	0.9 / 1.6 / 1.7 / 14.7
VI. Non-FLF studio 4				
observed	2316	7.0 / 13.4 / 0.7 / 0		
model (no FLF)		12.1 / 8.6 / 0.3 / 0	12.1 / 8.6 / 0.3 / 0	12.1 / 8.6 / 0.3 / 0
model (with FLF)		0.9 / 1.8 / 0.0 / 18.3	0.3 / 1.0 / 0.0 / 19.7	0.3 / 1.1 / 0.0 / 19.6

Notes: Predictions of the counterfactual analysis for average portfolio choices of retailers, by distributor. FLF studios 1 and 2 offer FLF terms in the data; Non-FLF studios 1-4 do not. "Non-FLF stores" do not take FLF terms from a FLF studio. "Observed" is observed portfolio choices; "model (no FLF)" is the model's prediction if FLF is not an option; "model (with FLF)" is the model's prediction if FLF is an option for the retailer.

Table 7: Average Predicted Retailer and Distributor Profits

	Mean store profits	Focal studio profits per store	Other studio profits (total) per store
I. FLF studio 1			
i. FLF stores			
model (no FLF option)	\$48,150	\$5,888	\$76,890
model (with FLF option)	\$48,620	\$5,910	\$76,760
ii. non-FLF stores			
model (no FLF option)	\$52,070	\$5,706	\$73,360
model (with FLF option)	\$52,260	\$5,354	\$73,370
II. FLF studio 2			
i. FLF stores			
model (no FLF option)	\$58,990	\$748	\$98,510
model (with FLF option)	\$59,230	\$945	\$98,430
III. Non-FLF studio 1			
model (no FLF option)	\$57,250	\$7,981	\$75,550
model (with FLF option)	\$58,100	\$5,996	\$75,560
IV. Non-FLF studio 2			
model (no FLF option)	\$57,760	\$6,472	\$78,150
model (with FLF option)	\$58,120	\$5,500	\$78,200
V. Non-FLF studio 3			
model (no FLF option)	\$56,830	\$5,033	\$82,330
model (with FLF option)	\$57,640	\$3,151	\$82,400
VI. Non-FLF studio 4			
model (no FLF option)	\$57,400	\$4,400	\$79,330
model (with FLF option)	\$61,190	\$954	\$79,330

Notes: Predictions of simulations when 44% of the LP interaction terms in the moment inequalities estimates are applied to retailers' profits. Column 1 reports mean store profits, column 2 reports average focal studio profits per retailer and column 3 reports total non-focal studio profits per retailer (summed over all non-focal studios). For each focal studio the first row reports the model's predictions when the option of taking FLF is not available. The second row reports predictions when FLF is available.

THE FOLLOWING IS NOT FOR PUBLICATION

Summary Statistics, Demand Elasticities and Second-Stage Demand Regression

Additional Summary Statistics

In this appendix, we discuss preliminary evidence and patterns from the data. Tables 8 and 9 provide additional information to supplement that in Table 2 of the paper. The number of titles released by distributors, and taken by stores, under different contract types are broken out by Box Office Group.

Table 10 provides information on the size distribution of stores choosing different types of contracts. We begin by calculating the percent of each store's titles that are taken under each contract type. We then break down this distribution into quintiles and report, in the first panel of Table 10, the average store size (tier) for each quintile. The results demonstrate that stores that accept very few titles on LP contracts (the lowest quintile) are the small stores - these stores take a relatively high proportion of their titles on RS contracts. The stores that accept a high proportion of their titles on LP contracts are on average larger stores. This is consistent with the adverse selection effect noted above: large stores tend to be located in high-demand markets and therefore expect high demand for their titles. LP contracts are most profitable for these stores. The pattern for FLF contracts is similar to that for LP: larger stores are more likely to accept a high proportion of their titles on FLF contracts.

The second panel of Table 10 looks at these patterns in more detail. For each quintile and contract type, we examine the percent of stores in that quintile/contract type that are store tiers 1-3 or store tiers 7-10. We normalize these percentages by the overall percent of stores that are in those tier groups across all quintiles and contract types. Thus, the result of 1.59 for tier 1-3 under LP and Quintile 1 indicates that store tiers 1-3 (small stores) are relatively over-represented in the first quintile of LP contracts (a value greater than 1 indicates over-representation, and a value less than 1 indicates under-representation). Overall, small stores are over-represented in the first, second, and third quintiles of LP contracts, the first and second quintile of FLF contracts and the third, fourth and fifth quintiles of RS contracts. The reverse pattern holds for large stores: these are over-represented in the fourth and fifth quintiles of LP and FLF contracts and in the first and second quintiles of RS contracts. However, similar to small stores, large stores are also over-represented in the first quintile of FLF contracts.

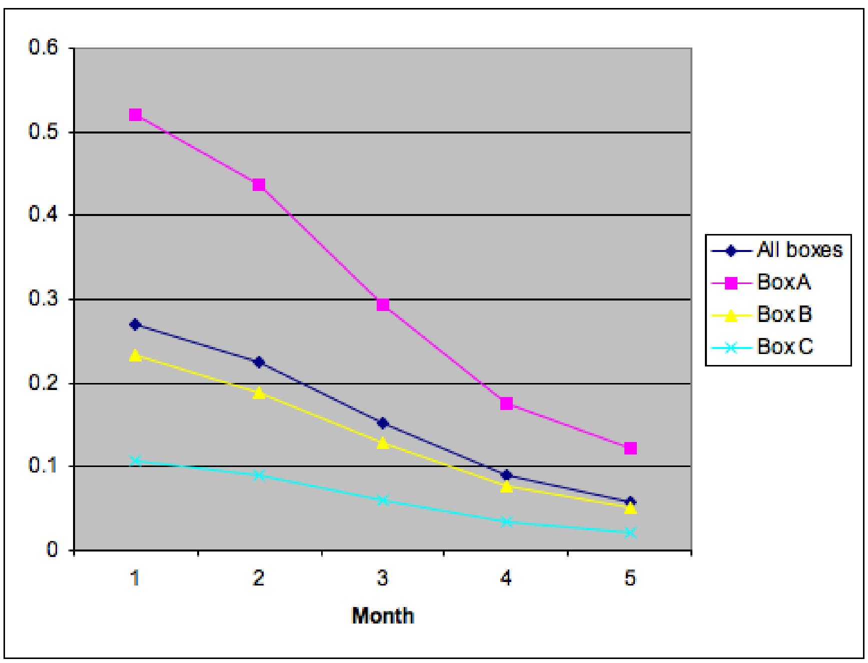
Demand Elasticities

The variation for inventory elasticities, as discussed in the paper, is displayed in Figure 1.

Second-Stage Demand Regression

Table 11 reports the results of a regression of the store-title quality levels estimated in the nested logit on store and title characteristics. Our dependent variable is the estimated value of $\left[\hat{\delta}_j + \hat{\gamma}_j z_m + \hat{\eta}_m + \hat{\theta}_t + \hat{\beta}_t x_j + \hat{\lambda}_t c_{jm}\right]$. Results for the first region are reported here; those for other regions are similar. The independent variables are title characteristics (quarter of release to video, box office category, genre, rating and interactions of these variables), store characteristics (demographics of the market, the number of households in the market and an indicator for markets where Blockbuster Video is active), interactions between title and store characteristics and the same month dummies and interaction terms that are included in the nested logit. The results are intuitive. Box office category A titles have higher estimated quality than those in categories B and (particularly) C. Action/adventure movies (the omitted genre category) and comedies have higher demand than other genres; children's movies, romances and science fiction movies have particularly low rental demand. PG13 movies have higher demand than those with other ratings. Markets with a high percent female consumers have high demand for video rentals; those with a high proportion of family heads who are single mothers have particularly high demand and those with a high proportion of family heads who are single without children have particularly low demand. The Blockbuster dummy is positive and significant, probably indicating that Blockbuster chooses to enter high-demand markets.[75]

Figure 1: Inventory Elasticities Implied by Demand Estimates



Notes: Elasticities implied by the demand estimates. Corresponding data are given in Table 4. Elasticities with respect to inventory are calculated for every store-title-month observation and then averages are taken within each zipcode region - month and then across regions.

[75]The coefficient on the number of households is negative and significant, implying that large markets where Blockbuster is not located have low demand. The coefficient on median income is negative and significant: wealthier markets have fewer movie rentals, perhaps because wealthy families choose more expensive leisure activities.

Table 8: Summary Statistics (Cont.)

Contract	Linear Pricing	Revenue Sharing	Full-Line Forcing	Sell-Through Pricing
Total No. of Titles Released by Distributors				
Year 1:	219	115	0	27
A Titles:	30	12	0	15
B Titles:	36	17	0	6
C Titles:	153	86	0	6
Year 2:	204	125	10	24
A Titles:	32	23	1	14
B Titles:	42	29	2	6
C Titles:	130	73	7	4
Year 3:	231	132	18	21
A Titles:	43	29	4	15
B Titles:	44	29	3	1
C Titles:	144	74	11	5
Year 4:	209	113	38	26
A Titles:	36	20	9	16
B Titles:	50	19	5	3
C Titles:	123	74	24	7

Notes: Total number of titles released by distributors and offered under each contract type. Titles may be counted in more than one column. All Revenue-Sharing and Full-Line Forcing titles are also offered under Linear-Pricing contracts, although many titles are offered under LP terms only. No Sell-Through Pricing titles are offered under alternate contracts.

Table 9: Summary Statistics (Cont.)

Contract	Linear Pricing	Revenue Sharing	Full-Line Forcing	Sell-Through Pricing
Number of Stores				
	6,358	6,150	5,111	6,171
Avg No. of Titles Taken by Stores				
Year 1:	99.72	23.74	-	20.41
	(44.18)	(24.83)	-	(6.78)
A Titles:	19.99	4.98	-	12.07
	(7.41)	(3.54)	-	(4.04)
B Titles:	23.85	5.23	-	4.29
	(9.54)	(5.38)	-	(1.62)
C Titles:	55.89	13.52	-	4.05
	(30.06)	(17.01)	-	(1.65)
Year 2:	69.64	20.31	4.15	15.24
	(45.03)	(21.69)	(3.15)	(7.89)
A Titles:	14.53	7.11	0.63	8.96
	(8.89)	(6.12)	(0.48)	(4.38)
B Titles:	20.03	6.88	1.23	3.93
	(11.90)	(7.67)	(0.85)	(2.39)
C Titles:	35.08	6.32	2.29	2.35
	(26.31)	(9.20)	(2.18)	(1.58)
Year 3:	98.98	18.61	6.29	14.70
	(56.36)	(23.28)	(3.90)	(6.77)
A Titles:	23.83	7.36	1.58	11.42
	(12.29)	(7.28)	(0.98)	(5.16)
B Titles:	26.18	5.23	0.92	0.78
	(13.66)	(7.46)	(0.66)	(0.42)
C Titles:	48.97	6.02	3.79	2.50
	(32.74)	(9.85)	(2.71)	(1.47)
Year 4:	88.77	14.26	10.36	18.14
	(40.12)	(17.57)	(7.26)	(7.16)
A Titles:	20.35	5.69	3.37	12.49
	(8.81)	(5.35)	(2.08)	(4.94)
B Titles:	33.30	3.69	1.06	2.39
	(13.08)	(5.36)	(0.97)	(1.08)
C Titles:	35.12	4.88	5.92	3.26
	(20.77)	(7.73)	(4.61)	(1.50)

Notes: Average number of titles of each contract type taken by all active stores in each year. Standard deviations in parentheses.

Table 10: Summary Statistics (Cont.)

Contract		Linear Pricing	Revenue Sharing	Full-Line Forcing	Sell-Through Pricing
Ave store tier					
Quintile 1		2.70	4.99	3.79	5.54
Quintile 2		2.93	5.16	2.76	4.70
Quintile 3		3.55	3.51	4.28	4.00
Quintile 4		4.74	3.01	4.29	2.93
Quintile 5		5.47	2.71	4.28	2.21
Quintile	% of quintile				
1	Tier 1-3	1.58	0.43	1.12	0.50
	Tier 7-10	0.53	1.60	1.42	3.07
2	Tier 1-3	1.42	0.40	1.48	0.55
	Tier 7-10	0.31	1.60	0.28	1.25
3	Tier 1-3	1.14	1.21	0.71	0.81
	Tier 7-10	0.74	0.84	0.81	0.45
4	Tier 1-3	0.48	1.39	0.83	1.40
	Tier 7-10	1.06	0.43	1.24	0.14
5	Tier 1-3	0.37	1.57	0.86	1.75
	Tier 7-10	2.36	0.54	1.26	0.08

Notes: Panel 1 breaks the percent of each store's titles adopted under a particular type of contract into quintiles and reports the average store tier in each quintile. Tiers are ranked from 1 to 10 where 10 is largest. Panel 2 reports the percent of stores in each quintile that are in store tiers 1-3 and 7-10 respectively. These percentages are normalized by the percent of all stores that are in the relevant set of tiers. Numbers over 1 indicate that the store type is over-represented in the relevant quintile.

Table 11: Demand Results: Second Stage Regressions

	OLS Coef (S.E.)	IV 1 Coef (S.E.)	IV 2 Coef (S.E.)
Release date:			
Quarter 2	-0.008 (0.004)	-0.012 (0.004)	-0.015 (0.004)
Quarter 3	-0.119 (0.004)	-0.120 (0.004)	-0.124 (0.004)
Quarter 4	-0.029 (0.004)	-0.040 (0.004)	-0.042 (0.004)
Box Office:			
B	-0.755 (0.042)	-0.685 (0.043)	-0.724 (0.045)
C	-1.363 (0.039)	-1.278 (0.041)	-1.317 (0.042)
Genre:			
Child/Family	-0.787 (0.051)	-0.600 (0.052)	-0.638 (0.051)
Comedy	0.172 (0.046)	0.265 (0.047)	0.250 (0.046)
Drama	-0.135 (0.023)	-0.069 (0.023)	-0.096 (0.023)
Horror/Suspense	-0.021 (0.031)	-0.021 (0.033)	-0.036 (0.034)
Romance	-0.821 (0.045)	-0.661 (0.046)	-0.688 (0.046)
Science Fiction	-0.721 (0.053)	-0.549 (0.056)	-0.530 (0.056)
Rating:			
PG	-0.021 (0.032)	0.027 (0.032)	0.044 (0.032)
PG13	0.052 (0.053)	0.171 (0.054)	0.198 (0.053)
R, NC17, NR	-0.006 (0.059)	0.115 (0.060)	0.124 (0.060)
Market characteristics:			
Median age	0.0073 (0.0006)	0.0084 (0.0006)	0.0067 (0.0006)
Median income	-0.0113 (0.0002)	-0.0114 (0.0002)	-0.0118 (0.0002)
Number of households	-0.0001 (3.4E-7)	-0.0001 (3.5E-7)	-0.0001 (3.6E-7)
Percent white	-0.0295 (0.0004)	-0.0289 (0.0004)	-0.0306 (0.0005)
Percent black	-0.0240 (0.0004)	-0.0233 (0.0004)	-0.0249 (0.0004)
Percent female	0.0163 (0.0020)	0.0128 (0.0020)	0.0209 (0.0021)
Percent single mother with kids	0.0063 (0.0013)	0.0064 (0.0013)	0.0079 (0.0014)
Percent single father with kids	-0.2546 (0.0037)	-0.2509 (0.0039)	-0.2526 (0.0040)
Percent single male	-0.3782 (0.0076)	-0.3797 (0.0078)	-0.3753 (0.0080)
Percent single female	-0.0382 (0.0043)	-0.0410 (0.0044)	-0.0390 (0.0045)
Percent married with kids	0.0196 (0.0005)	0.0194 (0.0006)	0.0227 (0.0006)
Percent with Bachelor's	-0.0115 (0.0003)	-0.0116 (0.0003)	-0.0110 (0.0003)
Blockbuster in market	0.6703 (0.0035)	0.6707 (0.0036)	0.6743 (0.0037)
Percent rural	0.0006 (0.0002)	0.0004 (0.0002)	0.0008 (0.0002)
Percent suburban	-0.0008 (0.0001)	-0.0009 (0.0001)	-0.0008 (0.0001)
N	407,006	407,006	407,006
R^2	0.43	0.40	0.40

Notes: Regression of estimated quality (including title fixed effect-store characteristic interactions, store fixed effects and all decay rate interactions) from nested logit on title and store characteristics. IV1 instruments for the within-group share only. IV2 instruments for both within-group share and inventory. Omitted category for Box is A; for Genre is Action/Adventure; for Rating is G. All specifications include interactions between title and store characteristics and between month fixed effects and title characteristics.