The Effects of Full-Line Forcing Contracts:

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1 Introduction

We consider the effects of full-line forcing or bundling contracts in the video rental industry. Studios offer their titles to video rental stores under three main contract types: linear pricing (LP), revenue sharing (RS), and full-line forcing (FLF). Under linear-pricing contracts, the store pays a fixed price per tape, usually between $65 and $70. Under revenue sharing the upfront fee is much lower (around $8-$10 per tape) but the store also pays a fraction (in the region of 55%) of the rental revenues to the studio. The full-line forcing contract provides better revenue-sharing terms than the RS contracts (fees of $3 per tape and sharing payments of 35 - 40 percent), but requires the store to buy minimum quantities of all the titles produced by the studio during the period of the contract (usually 12 months).[1]

We discuss three potential welfare effects of introducing FLF contracts in this application. First, if a store chooses a FLF contract when it would otherwise not have taken all of the studio's titles, this increases the number of the studio's titles that are available to consumers. We call this the "market coverage effect". Second, and conversely, the store may compensate for the requirement to take all of a studio's titles by dropping some titles produced by other studios, particularly if inventory holding costs are high. This is the "leverage effect" of bundling: the studio may offer a bundling contract for exactly this reason. Finally, stores on average respond to the high price per tape under LP contracts by purchasing fewer tapes per title under LP than under RS. This may lead to queuing and other inefficiencies for LP compared to RS titles. Since stores tend to choose RS contracts only for titles for which they expect to have low demand, the problem is mitigated only for low-value titles. When FLF contracts are introduced, the store is required to take all the studio's titles on revenue-sharing terms, implying that some titles will be pulled out of LP contracts and into contracts with much lower costs per tape. This reduces the inefficiency from the store's low inventory choices under LP. We refer to this as the "efficiency effect" of the FLF contract.[2] The overall effect of bundling on efficiency and welfare depends on the relative importance of these three effects and is an empirical question.

We develop an empirical model of the industry and perform counterfactual analyses to investigate the three effects of bundling contracts. We ask how different the market would look in terms

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[1] Studios sell some additional titles under "sell-through pricing" terms, in which all buyers, including video rental stores, can purchase tapes for around $20-$25 each. There is no contract choice for these titles, which usually include children's movies or titles with "teenager" appeal.

[2] Note that this relates specifically to the revenue-sharing nature of the FLF contracts in this industry.

of the number of titles offered to consumers, the mix of studios producing those titles, prices and store and studio profits if the availability of full-line forcing contracts was delayed. Our initial reduced-form analyses show that the overall patterns in the data are consistent with the market coverage and efficiency effects, but that the leverage effect may be small. Selection issues - in particular those caused by stores choosing which contracts to accept - mean that a structural model is needed to analyze the market fully.

Using a new and extensive dataset, we model consumer demand for titles using a flexible nested-logit framework that takes advantage of the detailed dataset by including both store and title fixed effects, as well as decay rates, prices and numerous interaction terms. The demand system accounts for competition across titles, and allows the choice set for consumers to adjust in each month based on the set of new titles released by studios. The missing link is then the cost of holding inventory: this is critical to our understanding of the market coverage and leverage effects. It includes rent, insurance and restocking costs, the value of reselling used tapes and also the potential value to the retailer of adding tapes in terms of drawing new customers into the store. We estimate this cost using a method of moments methodology with inequalities, following the approach developed in Pakes, Porter, Ho and Ishii (2007). Finally we perform counterfactuals to investigate the effect of delaying the introduction of FLF contracts for particular studios.

The counterfactual analyses indicate that store profits fall slightly when FLF introduction is delayed; they drop on average one of the FLF titles and switch most of the others to RS contracts. The FLF studio's profits fall substantially as a result. Overall our current results indicate that FLF contracts are on average welfare-improving: the leverage effect is likely to be outweighed by the market coverage and efficiency effects.

This analysis does not focus on the question addressed in the theoretical literature on bundling: the reason why upstream firms might choose to offer bundling contracts. Our results are, however, informative on this question. There are three potential explanations in our context. The first is the efficiency issue discussed above: if titles are pulled from LP contracts into FLF contracts this increases efficiency by increasing the inventory chosen per title. The theoretical literature does not consider this possibility, with the partial exception of Burstein (1960), which views full-line forcing as a means of achieving the effects of vertical integration. The second is the leverage theory: bundling or tying may be used to "leverage" market power in one market to exclude competitors in another market. This theory has been discussed in numerous theoretical papers including, for example, Whinston (1990), Choi and Stefanadis (2001), Carlton and Waldman (2002) and Nalebuff (2004). The third explanation is price discrimination. If the preferences of the downstream firms (rental stores in our application) for each good are negatively correlated, then the upstream firm (studio) can profit by bundling goods together. Adams and Yellen (1976) provide the first formal model of price discrimination through tying, building on a seminal paper by Stigler (1962). Their work was later generalized by McAfee, McMillian and Whinston (1989) and Salinger (1995) among others. Our demand model is sufficiently rich to accommodate this effect: a negative correlation in preferences across stores could be generated if the consumer population differs across markets and if preferences for particular titles vary across demographic groups. However, our data,which cover only 7 studios that offer FLF contracts, do not allow us to analyze the price discrimination story explicitly. We focus instead on the store's choice of whether to take the bundling contract. The demand model is also rich enough to consider this question, since it allows the store to predict which titles will be particularly popular with its population.

In contrast to Mortimer (2008), which studies the effects of vertical contractual arrangements in this industry on a product-by-product basis, we are primarily interested in the effect of bundling in the supply chain. To this end, we use a newly-collected dataset that extends the data used in Mortimer (2008) by two years in order to follow the adoption of the full-line forcing arrangements

in this industry. The focus on mixed bundling requires us to use a much more flexible demand system (compared to Mortimer) to allow for correlation in demand between titles, and to allow for a more flexible cost structure at the retail level. Despite the adoption of the new DVD technology in the industry that is primarily sell-through priced, full-line forcing arrangements continue to be an important contractual form in the industry for both VHS and DVD, largely supplanting the product-by-product arrangements that were common in earlier years for VHS. In addition, full-line forces (or related "softer" arrangements like rebates or slotting fees in exchange for carrying a manufacturer's full line) are common in many other industries, from groceries and vending to other retail markets, which have not necessarily used revenue-sharing contractual forms at the single product level.

There are to our knowledge very few previous empirical bundling papers. The first is by Chu, Leslie and Sorensen (2007). It studies bundling of tickets sold to consumers by a theatre company that produces a season of 8 plays. The authors focus on examining the profitability of simple alternative pricing strategies to mixed bundling, and show that these alternatives can yield profits that are very close to those of mixed bundling. Second, Crawford (2008) argues that he finds evidence of discriminatory incentives for bundling in cable TV. There is also a small literature that uses reduced form analyses to investigate the pro-competitive and anti-competitive effects of slotting allowances (which are paid by manufacturers to supermarkets in order to reserve shelf space for their products). See for example Marx and Shaffer (2004). To our knowledge no previous authors have estimated a structural model of bundling in a supply chain setting.

Understanding the effects of full-line forcing contracts is of quite general interest, and speaks broadly to two literatures. First, the literature on bundling/tying discussed above focuses on the benefits that firms receive from these types of arrangements through their ability to mimic price discrimination or apply leverage across markets. Second, the literature on vertical arrangements focuses on the potential of such arrangements to both soften competition (through foreclosure or by raising rivals' costs) and induce efficient investments. All of these mechanisms may be present in full-line forcing contracts, since they combine bundling with the additional complications of vertical arrangements. In the example we study, this is particularly salient because the full-line forcing terms include a revenue-sharing component, potentially strengthening the incentives in the vertical chain. Understanding the welfare effects of such contracts is an empirical question, because although the contracts may be welfare enhancing from the point of view of the firms involved, consumer welfare can go either way.

Note that the three effects that we discuss (market coverage, leverage, and efficiency) are impacted by both the tying and revenue-sharing components of the contracts we study. Tying affects the decision to take a title (market coverage), but revenue-sharing terms may further affect the number of tapes taken (i.e., the size of a store's inventory). A similar issue holds for leverage: the full-line forcing contracts used here can affect both the decision to hold another studio's titles as well as the size of those titles' inventories. Finally, the efficiency effect depends on both the tying and the revenue-sharing aspects of the contracts as well: tying is required to induce firms to forgo less efficient linear pricing contracts on high-value titles, and revenue-sharing terms are necessary to reduce upfront fees so that inventory levels are closer to what an integrated firm would choose.

Finally, the legal environment makes full-line forcing arrangements (and their welfare impacts) particularly interesting. As noted by Shy (1995), referring to U.S. law, "courts have been more receptive to vertical arrangements that did not involve price restraints." This is due in part to the potential for conflict between Federal anti-trust laws that govern price fixing and state laws that govern fair trade between firms. To the extent that firms can navigate their vertical relationships via non-price strategies (such as tying/bundling, revenue-sharing, quantity requirements, etc.), the potential for facing allegations of anti-trust violations may be reduced. As a result, such strategies

are widely-adopted in vertical settings in many industries, making our study an important fist step for understanding the implications of these types of arrangements more generally.

This paper continues as follows. In Section 2 we outline the important institutional features of the industry and discuss the empirical implications of the theoretical literature on tying. Section 3 describes the data; Section 4 sets out our reduced form analysis. In Section 5 we provide an overview of the model. Section 6 considers demand, Section 7 covers the inequalities methodology and Section 8 describes our counterfactual analyses. Finally, Section 9 concludes.

2 Full-Line Forcing in the Video Rental Market

This section summarizes some important institutional features of the market and discusses the implications of tying for efficiency in this industry.

2.1 The video rental market

The video rental industry has two primary tiers[3]. Studios make and distribute movies which are acquired by video rental stores who offer them for rental and sale to consumers. The studios use three different contractual forms for titles targeted to the rental market. The first is linear pricing. Studios offer a title to a store for a fixed price per tape, usually between $65 and $70. They may also offer quantity discounts (introducing some second-degree price discrimination).

The second contractual form is revenue sharing. A studio and a rental store agree to share the revenue generated by a title, in return for charging a reduced upfront fee. In the typical revenue sharing agreement the studio charges a upfront fee of around $8 per tape and typically 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. Revenue sharing and linear pricing contracts both operate on a per title basis. That is, for each individual title, the rental store is free to choose both whether to purchase the title and which form of contract to take.

In contrast, the third form of contract, the full-line forcing contract or output program, requires the rental store to purchase all titles released by the studio during the period of the agreement (typically 12 months) and to take them all under the same contract type[4]. In many other respects full-line forcing contracts resemble revenue sharing agreements. For each title, the studio receives an upfront fee per tape and a share of the revenues, both of which are usually lower than the revenue sharing terms. The quantity taken by the retailer is again restricted to be within a range, where the lower bound (on average 11 tapes per title) is again frequently binding.

Studios have only a limited ability to price discriminate across retailers. The 1936 Robinson-Patman Act prevents distributors from offering different prices to competing buyers for exactly the same product. Furthermore, copyright laws permit stores to freely resell tapes purchased from studios 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

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

[4] Some exceptions apply: titles released by the studio on "sell-through pricing" terms are exempt, and several studios 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 studio releases more than 3 titles in a month (a rare event), the retailer is only obligated to accept three of them. Finally, full-line forcing contracts also typically include opt-out clauses for movies with 'objectionable' content.

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 revenue-sharing contracts also vary by studio 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 contractual terms the distributor can in theory choose which of the contractual forms to offer. In particular one might expect the studio to choose not to offer linear pricing contracts since these are the least flexible contractual arrangements. In reality, however, revenue-sharing contracts were not qidely used before the end of 1997, and full-line forcing contracts were not introduced until the middle of our dataset, in February 1999. Both contractual forms require extensive computer monitoring of millions of transactions; only about half of the stores in the industry had the technology to adopt these contracts by 1998[5]. Thus elimination of linear pricing contracts during the period of our data may have substantially reduce studios' target market[6]. This implies that rental stores can discipline the studios by opting to take linear-pricing terms when revenue-sharing splits are not satisfactory. The empirical evidence suggests that linear-pricing terms continue to be offered to all firms even when revenue-sharing terms are also available.

One further institutional detail concerns "sell-through priced" titles. These include, for example, children's movies and some very popular titles: the studio sells these movies to all buyers, including video rental stores, for quite low prices, often around $20-25 per tape[7]. There is no contract choice for sell-through priced titles: 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 we do not model the contract choice.

Finally, note that the sales market is important for studios and should be included in any model of their choices of contract types. However, sales provide only a small proportion of the revenues of rental stores whose choices are the focus of this paper.

2.2 Empirical Implications of Theory on Tying

We consider three potential welfare effects of introducing FLF contracts. First they affect retailers' inventory choices. The high cost of tapes under LP causes stores to choose low inventory levels for LP titles compared to the inventory choice of a vertically-integrated firm. The inefficiency is reduced when titles shift to RS contracts because the average cost per tape falls[8] and the store's inventory level increases. However, when only revenue sharing and linear pricing contracts are available and demand is independent across titles, retailers will choose linear pricing terms when expected demand for the title is relatively high.[9] Thus the efficiency loss from low inventory choices may not be mitigated for high-value titles, for which the loss is relatively large. This is the source of the "efficiency effect" of a full-line forcing contract: since the contract requires the store to take all of the relevant studio's titles under terms that include a low upfront fee and a low average cost per tape, valuable titles are pulled out of linear pricing contracts, which may significantly reduce

[5] Our dataset includes only stores that have the technology to do revenue-sharing contracts.

[6] Studios 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 linear-pricing terms unless all retailers are excluded from these terms.

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

[8] In a regression of retailer payments to the studio per tape on contract type, title fixed effects and store demographics, the average payment per RS tape was $34 lower than the average under LP (standard error 0.02). The average under FLF was $41 lower than that under LP (standard error 0.06).

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

the low inventory problem.

The low inventory effect may not substantially affect the prices charged to consumers. There are two opposing effects here. First, the high cost of inventory under LP provides an incentive to increase the rental price for LP compared to RS or FLF titles. However, once the inventory has been purchased, the store has an incentive to price LP titles below the RS or FLF titles that compete with them, in order to draw consumers to the titles for which they capture 100% of the rental revenues. These two offsetting effects may imply small differences in rental prices between contract types.

There are two other potential welfare effects of introducing full-line forcing contracts. First, if the store previously took only a subset of the studio's titles, the fact that it must now take all of them implies a positive effect on market coverage. This is probably welfare-improving since it increases the size of consumers' choice sets. (It may also be consistent with the price discrimination motive for bundling by studios.) Conversely, this effect together with the non-zero cost of holding inventory may prompt the store to drop other studios' titles: this is the leverage effect and is likely welfare-reducing since it reduces inter-studio competition.

The relative magnitudes of these three effects will depend on the mean and variance of demand for the titles produced by different studios and the extent of complementarities between them and also on stores' inventory holding costs. The aggregate welfare effect of full-line forcing contracts is therefore an empirical question.

3 The Dataset

Our primary data source is Rentrak Corporation, an organization that distributes movies under revenue-sharing and full-line forcing contractual arrangements and monitors these contracts to facilitate payments between retailers and studios. The complete dataset combines information from previous studies (Mortimer 2007 and 2008) with additional information from Rentrak on full-line forcing 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 1025 titles released during these months.

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 per cent) represent store closure[10]. 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.

[10] For 1116 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.

For each title we observe a studio identifier (but not the actual studio 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 revenue-sharing and full-line forcing contracts offered to retailers for each title, and retail prices under linear-pricing contracts. Rentrak 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 7,189 stores, 963 titles (201 in the A box-office category, 188 B titles and 574 C titles) and 59 studios in the dataset.

Full-line forcing contracts were first introduced in February 1999 of the dataset. 7 out of 59 studios offer a full-line forcing contract at some point in our panel. The average number of titles released per year by these 7 "FLF studios" was 10.5; the maximum was 18.75 and the minimum 1. The 52 "non-FLF" studios released on average 7.2 titles per year, with a maximum of 39.25 and a minimum of 0.25. Of the 7,189 retail stores in the clean dataset, 7,107 participated in at least one linear pricing contract during the period of the analysis, 6,687 participated in at least one revenue-sharing contract and 4,896 participated in at least one full-line forcing contract. On average stores take 42% of the titles released per studio-year. The proportion is higher for FLF studios (69%, or 43% if we include only stores that have no FLF contracts with the relevant studio) than for other studios (38%). That is, FLF studios both release more titles per year and also have higher take-up rates than other studios.

Stores are categorized into ten sizes, called "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 12.2 in tier 1 to 15.3 in tier 6. It then falls in each subsequent tier to a low of 10.3 in tier 10. The average number of tapes taken per month increases with every store tier, from 58.7 in tier 1 to 360.1 in tier 10. The average number of titles taken per month differs very little between stores that take FLF contracts and those that do not. However, "FLF stores" take more tapes per month than "non-FLF stores" (165.6 vs. 105.8 on average).

Additional summary statistics are provided in Tables 1 to 4. 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 price for linear-pricing contracts is $66.82, compared to an average upfront fee of $8.48 for revenue-sharing contracts, $3.60 for full-line forcing contracts and a price of $15.17 for sell-through price contracts. Retailers on average keep 46% of revenues under revenue sharing contracts and 59% of revenues under full-line forcing contracts. The minimum number of tapes per title is 10 on average for RS contracts and 11 for FLF contracts. On average, the maximum number of tapes allowed per title is 23 and 22 respectively. Average month 1 rentals are highest under revenue sharing contracts but the decay rate is also greatest for these titles; by month 3 linear priced titles have higher demand and this remains true in months 4 and 5.

Average inventory levels are highest for titles purchased under sell-through pricing and revenue sharing contracts and lowest for those under linear pricing contracts. This is the source of the efficiency effect described above. Not surprisingly, retailers also extract the largest number of rentals per tape for titles purchased under LP contracts. As discussed in Section 2, the two offsetting effects of contract types on prices lead to average rental prices (measured as average revenues per rental, including late fees) that differ very little across contract types. 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).

Tables 2 and 3 summarize the numbers of titles offered by studios, and taken by stores, under different contract types. The majority of titles in our data were offered under linear-pricing contracts; approximately 70% were also offered under revenue-sharing contracts. No full-line forcing contracts were offered in the first year of our data; a total of 10 were offered in year 2, 18 in year 3 and 39 in year 4. Table 3 shows that stores on average took many more titles on LP contracts than on other contract types.

Finally, Table 4 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 were taken under each contract type. We then break down this distribution into quintiles and report, in the first panel of the table, 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 choose to 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. 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 the table looks at these patterns in more detail. We ask what percent of stores in the lowest quintile of (% of titles adopted under LP contracts) are in store tiers 1-3. We then normalize by the percent of all stores that are in those tiers. The result (a figure of 1.35) indicates that small stores are over-represented in the first quintile of LP contracts. Overall, small stores are over-represented in the first and second quintiles of LP contracts, the first 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 fifth quintiles of LP and FLF contracts and in the first and second quintiles of RS contracts.

4 Reduced Form Evidence

We now discuss preliminary evidence and patterns from the data. In particular, we ask whether reduced-form analyses can provide any evidence on the importance of the efficiency, market coverage and leverage effects of full-line forcing contracts.

4.1 Retailer Performance Across Contract Type

First we test the prediction that retailers who expect a relatively low draw of demand for a particular title will choose a revenue-sharing contract while retailers who expect high demand for that title will choose linear pricing. Full-line forcing contracts are not necessarily predicted to be correlated with low demand. The summary statistics above indicate that large stores (which tend to have high demand) are most likely to choose LP contracts, small stores are more likely to choose RS contracts and the stores choosing FLF are similar to those choosing LP. We expect a similar pattern here. We regress store revenues on an indicator for the adoption of a revenue-sharing contract, an indicator for the adoption of a full-line forcing contract and title fixed-effects at the store-title level. Consistent with our prediction, we find that revenues for Box Office group A titles are approximately \$109 lower under revenue-sharing than under linear pricing contracts (standard error of 1.33) and that revenues under full-line forcing are not significantly different from those under linear pricing (coefficient of -10.15, standard error 5.47).[11] The relationship between RS and LP revenues is similar for Box Office group B and C titles.

Next we investigate in more detail which types of stores choose full-line forcing contracts. A logit regression of a dummy for participation in these contracts on observable store characteristics indicates that larger stores and those in suburban areas are more likely to adopt full-line forcing contracts. Stores facing competition from a Blockbuster Video are more likely to adopt full-line forcing.

Finally, we would like to investigate whether the introduction of revenue sharing and full-line forcing contracts had a positive effect on market coverage. First the statistic noted earlier, that stores on average take 43% of titles released by studios that offer FLF contracts at some point, excluding FLF contracts themselves, is consistent with a potentially large effect. Second, we consider a number of summary statistics separately for 15 different geographic regions of the country (since the dataset is too large for us to run some of the regressions using all the data together). For stores in the first region[12], the average number of titles taken per month from studios from which the store takes a FLF contract in some other month is 0.59. The average increases to 1.32 titles per month in FLF months, suggesting a positive market coverage effect. We regress the number of titles taken per studio-month, the number of tapes per title and the number of transactions per title on an indicator for active FLF contracts for the relevant store-studio pair and store fixed effects. We include only store-studio pairs for which a FLF contract exists at some point in our panel. We are therefore looking within-store and asking whether taking a FLF contract from a particular studio is correlated with inventory choices, and rental activity, specific to that studio. The coefficient on FLF activity in the regression considering the number of titles taken per studio-month is positive and significant (coefficient 0.76, standard error 0.02, from a mean in the data of 0.70). That in the regression considering the number of tapes per title is 1.01 (standard error 0.24 from a mean of

[11] The results imply that the effect of low inventory choices for LP contracts, which are likely to reduce demand for these titles, is outweighed by the quality difference generated by the difference in tariffs between LP and RS contracts.

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

12.5). This implies a positive market expansion effect in terms of both the number of titles taken and the number of tapes per title. However, the equivalent coefficient in the transactions regression is negative and significant (coefficient -63.0, standard error 4.18 from a mean of 231). The new titles taken under the FLF contract generate fewer rentals than other titles. The results are similar across zip code categories.

4.2 Full-line Forcing and Competing Products

Our final reduced-form analysis investigates the leverage theory: that full-line forcing can have anticompetitive effects in the upstream market by reducing retailers'orders from other studios. We might expect this effect to generate a negative correlation between the adoption of full-line forcing contracts by a retailer and the orders (or rentals) of products from other, non-bundling studios. However, most of the theories that generate such predictions consider full bundling rather than mixed bundling. In our application large stores' selection into different contractual forms may alter the intuition.

First we note that, for stores in the first region, the average number of titles taken per month from studios from which the store never takes a FLF contract, in months where it has no active FLF contracts, is 0.281. The equivalent number for months in which the store has some FLF contracts (with other studios) is 0.224. The raw data therefore indicate the potential for a modest leverage effect in terms of the number of titles taken. We then regress the number of titles taken per studio-month, the number of tapes per title and the number of transactions per title on an indicator for active FLF contracts in this month with some other studio. We include store fixed effects and exclude from the regression studios with which the store ever has a FLF contract. The coefficient on the number of titles taken per studio-month is negative and significant but very small (coefficient of -0.064, standard error 0.003 compared to a mean in the data of 0.24, standard deviation 0.75). The coefficient on the number of tapes per title is 0.21 (standard error 0.10 from a mean in the data of 9.7). That on transactions per title is -21.9 (standard error 1.74, mean in the data of 183.2). Overall, then, the simplest reduced-form regressions imply that there may be a leverage effect in terms of the number of titles taken per studio-month, but this is small and the number of tapes taken per title may even increase. The number of transactions per title from other studios falls somewhat, presumably due to a substitution effect when additional titles are added from the FLF studio. The results from other zip codes are consistent with this summary.

5 Overview of the Structural Model

The summary statistics and reduced-form analyses provided some evidence that FLF contracts may affect the efficiency of contract types chosen for particular titles. The analysis is also consistent with the market coverage effect and indicates that the leverage effect may be small. A structural model is needed to correct for the selection problem arising from stores choosing which contract types to take. For example, large stores are more likely than others to select FLF contracts. This issue makes it difficult to predict the effect of introducing new FLF contracts from the reduced form results alone.

The modeling approach we propose has three elements. First, we estimate a demand system that parsimoniously captures the demand interactions between titles and across title categories. Since the impact of FLF contracts is to change the composition of the choice set, the inventory of each title and the price per rental, the focus of this demand system will be to capture the impact of adding or removing a title from the consumer's choice set and changing inventory and price. The second step is to use moment inequalities to infer the store's 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 division of the surplus between studios and stores and on consumer surplus.

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. As noted above, LP contracts are likely to be chosen in preference to RS when the store expects high demand for a title. 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 done 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[13].

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 for X released in the same month, then its rentals are likely to fall (and in fact the store may choose not to take it at all) which could imply an overall reduction in retailer profits for this pair of titles[14]. 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[15]. Our model captures the second of these three effects; the impact of the other two on retailer profits will be included in the cost of taking an extra tape estimated in the inequalities analysis[16].

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]

[13] 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.

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

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

[16] There is another cross-month effect here. If X and Y are released in the same month and the store chooses to stock title Y despite the reduction in demand in its release month, then consumers who rented title X in month 1 would be more likely to rent Y in the following month than they would have been before X's inventory increased. That is, because of the durable goods aspect of demand, title Y's decay rate is likely to be affected by an increase in X's inventory. Our demand model contains an average decay rate that varies by type of title but does not identify these decay rate changes. If Y substitutes for titles other than X in month 2 then in expectation it will not affect retailer profits since on average the two titles have the same contract terms and similar prices. However, if Y substitutes for X this could increase retailer profits. We expect this to be a second order effect since substitution from X would occur only for consumers who would have rented X twice.

[17] We assume that, if the store switches to taking a FLF contract, it places all the studio's tapes on the shelf rather

6 A Model of Demand

6.1 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 which are unrelated to true demand; allowing consumers to substitute across weeks within each month mitigates this problem. Unfortunately 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.[18] Our methodology is as follows. For any title released in month one, we summarize over weeks 1 through 4 to generate month 1 demand[19]. Similarly, we summarize 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.[20] 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 the title's competitors in each month as the titles that were 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.[21,22]

We estimate a nested logit model of demand with nests defined as genre/box office class groups

than storing some in a back room. If this assumption is incorrect our inequalities analysis will estimate a very low cost of holding inventory under FLF contracts.

[18] 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.

[19] We replace missing or negative values for weekly revenues or transactions with zeros. Average prices are constructed by dividing monthly revenues by the number of transactions in the month.

[20] Note that titles released in the last week of a month will be tracked for just one week in the first month rather than 4 weeks, which will bias down the demand estimates for those titles. Fortunately, there appears to be no correlation between this and studios, 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 will be smaller than those for titles released earlier.

[21] Our full dataset includes titles released between months 1 and 54 of our panel. Titles released between months 1-4 and between months 49-54 compete with those released in months -3 to 0 and 52-57 respectively, which we do not fully observe. We therefore exclude months 1-4 from the final demand and inequalities analysis in addition to titles released after month 48, ensuring that we include only months for which we observe the full choice set and at least 6 monhts of rental activity.

[22] We choose to pool the data across months rather than estimating demand separately in each month because the variation in choice sets offered across months enables us to identify a detailed set of interactions with the decay rate; see below. This approach also requires fewer normalizations: if we estimated month-by-month, each month would have an outside good which would need to be normalized to zero to enable cross-month comparisons.

(i.e., "A" comedies). [23] The demand equation is:

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

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 $[\zeta_{igt} + (1-\sigma)\varepsilon_{ijmt}]$ 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 per cent white, the per cent single and the per cent with children. We therefore permit each store to predict the demand for a particular title based on the demographics of local consumers[24].

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.[25] 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)[26]. This implies constraining the decay rate to be the same for all titles in a particular box office class-genre-rating cell[27]. 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:

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

[23] 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 class 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.

[24] 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.

[25] 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.

[26] 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.

[27] There is one further issue which we would ideally account for by including title-month fixed effects. If title A was introduced in month 4, it competed with and therefore affected demand for title B in month 7. It therefore had 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 visiting a different store. The relevant dimension of competition, particularly since we are considering bundling, is that across movie studios within a store rather than that across stores. We model the former carefully but do not go into details on the latter[28]. 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 will be 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: the price variable, inventory and $s_{jmt/gmt}$, the share of the title within its group. Since the demand model includes store, title and month fixed effects we are concerned about endogeneity only through unobservables that change over time in one store or title differently from others and that affect changes in prices, in inventory and in the $s_{jmt/gmt}$ term. We instrument for inventory using the average inventory of the same title across stores of the same tier[29]. The assumptions needed to make this a valid instrument are that similar-sized stores choose similar inventory levels for the same title (i.e. costs are similar for similar-sized stores) and that demand shocks are uncorrelated across markets.

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.

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

[29] 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.

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

We tried numerous instruments for price, including measures of variable costs and average prices of other similar titles. None of the instruments were successful. The issue is that, after including store, title and month fixed effects, the only unobservable we need to instrument for is at the store-title level. Variation in price at this level exists across months: 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. To the extent that such activities are endogenously determined, however, our estimates will bias our price coefficient upwards. Unfortunately, we have not found instruments that are correlated with this price variation. We therefore conduct our analysis without instrumenting for price. We report in Section 6.2 the OLS results and those that instrument for inventory and the $\ln(s_{jmt/gmt})$ variable[30].

It is worth noting here that there were other potential demand methodologies. We would ideally have interacted title and store fixed effects in the nested logit; unfortunately the number of parameters to be estimated would then have been infeasibly large. Alternatively we could have estimated a random coefficients model. However, this would have implied 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.[31]

6.2 Demand Results

We report results for the first geographic region in Table 5. 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 class, genre and rating and interactions between these). Column 1 of the Table 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. This good fit with the data is particularly useful since our supply side estimation will stay within-sample in terms of titles and stores, allowing stores to deviate only in terms of contract choices. We will therefore use all the estimated fixed effects in our inequalitites and counterfactuals.

[30] We also estimate a demand equation using share of revenues, rather than share of transactions, as the dependent variable. We use exactly the same specification as in our primary model, but define each title's market share in a particular store-month as the revenue to the store from this title-month divided by total potential revenues (the average price over all titles for the relevant store-box office group multiplied by the same market size used in the main model). We use this approach rather than defining the denominator as the total revenues in the store-month in order to allow consumers to choose the outside good of not renting a title. This method implies an assumption that stores do not cut prices in order to attract new customers, which seems unlikely given that observed prices differ very little across titles. The estimated coefficients (on all variables other than price, which of course is excluded from the specification) are very similar to those from the main model. We could in future repeat our supply side analysis using the results from this specification. This would act as a robustness test of our assumption that there is enough price variation left in the data to estimate a reliable price coefficient that can be used to predict store revenues under counterfactual contract terms. (Of course this robustness test would not permit us to analyze consumer welfare without making an assumption about price elasticities of demand.)

[31] 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.

The price coefficient in the OLS regression is negative and significant (although small). 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 also 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 plan to repeat the demand analysis for each of the 14 other regions. This has not yet been completed for the current specification. However, in a previous iteration, which had very similar results for the first geographic region, the price coefficient was negative as expected for all but one region. 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. There was little variation in results across the remaining 14 regions.

Table 6 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 month since release. The average elasticity with respect to price over all months since release is -0.122. The average elasticity with respect to inventory is 0.153. Table 6 also documents the variation in elasticities both across months since release of the title and across Box Office Groups. There is very little variation over time for the price elasticities.[32] The value in month 3 is -0.126, the minimum is -0.130 and the maximum is -0.114. The variation for inventory elasticities is displayed in Figure 1. 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 groups, and for each group the elasticity decreases over time since release. 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 so much buzz and are less influenced by these kinds of advertising.

Table 7 sets out 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 are again reported for the first region. 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

[32] Since there is only a single price coefficient, variation in elasticities across months and box-office groups is generated from variation in the level of demand and price across months and box office groups.

interaction terms that were included in the nested logit. 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 (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[33]. The R^2 on these regressions is only 0.4: even with a very flexible functional form, our title and store characteristics are able to explain less than half of the variation in the data. This is the reason for using a nested logit framework, in which we can feasibly include both title and store characteristics, rather than adopting a random coefficients model.

[33]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.

7 The Supply Side: Moment Inequalities

Having estimated a detailed demand model, the final piece of information needed to analyze stores' choices of contract types is the cost of holding additional tapes. As noted in Section 5, this includes rent, insurance, restocking costs, the potential value of selling used tapes and of drawing new customers into the store, and also the effect of an increase in inventory of one title on later rentals of other titles that is not incorporated in the demand model. Together these may imply either a positive or a negative estimated average cost of taking additional tapes.

We use the method of moments inequalities estimator developed in Pakes, Porter, Ho and Ishii (2007) to estimate inventory holding costs. That paper shows how to use inequality constraints resulting from a Bayes-Nash equilibrium assumption in both single-agent and multiple-agent games to generate conditions that can be used for estimation and inference. The intuition in our case is very simple: we assume that each store's profit from its observed portfolio of titles and choice of contract types must be greater than its profit from any of its alternative choices. We use this assumption to write down a series of inequality constraints. The demand specification will model the change in the number of rentals caused by the change in inventory holdings, prices and the consumer's choice set that result from a contract type deviation. This, together with the price change and change in the number of tapes purchased and the purchase price, will determine the main input to the inequalities analysis: the profit change up to the inventory holding cost.

We derive inequalities from every store's choice of contract for every title.[34] We assume that the store has perfect foresight regarding the titles to be released to video in the following five-month period[35] (or the following year for FLF contracts) but that it may imperfectly predict demand for those titles or the cost of holding inventory. Our assumption, noted above, that each store operates in a separate market implies that no further informational assumptions are needed. We can now write down inequalities that are sufficient to place bounds on the inventory holding cost.

7.1 The Store Profit Equation

Our first step is to predict the total return to the store from its contracts with all studios 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 each title for each store in the market:

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

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 that are held by this particular store m in month t (other stores are excluded under the assumption that each store essentially operates in an independent market).

Next we consider the return to the store for each title: this is the revenue earned throughout the months after its release less the total payment to the studio. We denote the return from title j under the three contract types as follows:

[34] This excludes sell-through priced titles, for which there is no contract choice.

[35] This assumption may well be reasonable: titles' box office release dates are in general more than five months before their release to video so store managers observe which titles will be available several months in advance.

1. Under linear pricing the return for title j is $r_{jm}(.) = \sum_{t=t_j}^{t_j+4} q_{tjm}p_{tjm} - F_j c_{jm}$. Here c_{jm} is the capacity of the title (the number of tapes purchased), q_{tjm} is the number of rentals and t indexes time (in months) since the release date t_j.

2. Under revenue sharing we write $r_{jm}(.) = y_j^{RS} \sum_{t=t_j}^{t_j+4} q_{tjm}p_{tjm} - u_j^{RS} c_{jm}$, where y_j^{RS} is the portion of revenues kept under RS.

3. If the store chooses a full-line forcing contract it has to buy all titles produced by the studio during the following twelve months. It receives better terms than those under revenue sharing: $r_{jm}(.) = y_j^{FLF} \sum_{t=t_j}^{t_j+4} q_{tjm}p_{tjm} - u_j^{FLF} c_{jm}$. Thus $u_j^{FLF} \leq u_j^{RS}$ and $y_j^{FLF} \geq y_j^{RS}$.

We also need to model capacity constraints and quantity restrictions. The number of rentals is constrained by the inventory of the title, c_{jm}, and the maximum feasible number of rentals per tape, τ_{jm}.[36] Additional constraints, in the form of minimum and maximum quantity restrictions on inventory purchases, are also set by the studio for RS and FLF contracts (at the store-title level). We denote these constraints as $\underline{c}_{jm}$ and $\bar{c}_{jm}$ respectively. Then the quantity that would be rented out in the absence of quantity restrictions is:

$$\hat{q}_{jmt} = \min\left(Ms_{jmt}(.), \tau_{jm}c_{jm}\right) \tag{6}$$

The quantity actually rented out is given by:

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

where

$$\tilde{c}_{jm} = \max\left(\underline{c}_{jm}, \min\left(c_{jm}, \bar{c}_{jm}\right)\right) \tag{8}$$

accounts for the effect of the quantity restrictions.

The above implies that the return to the store from a particular title, over the four-year period covered by the data, is given by:

$$\begin{aligned} r_{jm}^{obs}(.) \;=\; & I_{jm}^{LP}\left(\sum_{\tilde{t}=t_j}^{t_j+4} \tilde{q}_{\tilde{t}jm}p_{\tilde{t}jm} - F_j\tilde{c}_{jm}\right) \\ & + I_{jm}^{RS}\left(y_j^{RS}\sum_{\tilde{t}=t_j}^{t_j+4} \tilde{q}_{\tilde{t}jm}p_{\tilde{t}jm} - u_j^{RS}\tilde{c}_{jm}\right) \\ & + I_{jm}^{FLF}\left(y_j^{FLF}\sum_{\tilde{t}=t_j}^{t_j+4} \tilde{q}_{\tilde{t}jm}p_{\tilde{t}jm} - u_j^{FLF}\tilde{c}_{jm}\right) \end{aligned} \tag{9}$$

where time is measured in months. As before we consider the first 4 months of the lifetime of each title plus a fifth observation for months 5 and above. The indicator functions I_{jm}^k equal 1 if contract k is chosen and 0 otherwise.

[36] This is a statement about the technology in use: the maximum number of rentals per title is constrained by the number of times a tape can be rented out before it breaks. In our analysis we define τ to be the maximum number of rentals per tape that the store is observed to provide for titles in the same box office class and contract type in the same month after release. We could add more structure here, accounting for the fact that if a tape breaks in one month it will be unavailable to consumers in later months, but expect this to be a second-order effect in our analysis.

Given this function $r_{jm}(.)$, we can write the store's profit from its observed contracts as:

$$\pi_m^{obs}(.) = \sum_s \sum_{j \in J_s} \left(r_{jm}^{obs}(F, u, y, \bar{c}, \underline{c}, \hat{\delta}, \hat{\gamma}, \hat{\eta}, \hat{\theta}, \hat{\lambda}, \hat{\alpha}, \hat{\sigma}, \hat{\xi}, \tilde{c}, k) - C(x_m, x_j, \mu)\ \tilde{c}_{jm} \right) + \eta_m + \rho(\tilde{c}_{ms}, k_{ms}) + \varepsilon_{ms} \quad (10)$$

where J_s is the set of titles produced by studio s during the time period covered by our data and $C(x_m, x_j, \mu)$ is the inventory cost of holding each tape. We estimate this as a reduced form function of store and title characteristics; μ is the parameter vector to be estimated. When the store chooses not to stock a title, we assume it makes no contribution to the store's profit. η_m is a store fixed effect, k_{ms} is the contract type (a vector with one element per title for this store-studio couple) and $\rho(\tilde{c}_{ms}, k_{ms})$ is the effect of the store's choice of contracts at the end of the four-year period on its profits after that period[37]. The final term, ε_{ms}, is an unobservable such as store prediction error in the inputs to demand or in the cost of holding inventory.

We account for store capacity constraints by introducing a cut-off condition on inventory. If a particular contract would require the store to take more inventory than a cut-off defined as 110% of the maximum inventory ever taken by the store in any month in our data, then the store adjusts the inventory so that the total number of tapes taken falls below the cutoff. Stores therefore cannot exceed their maximum capacity levels; below those levels all stores' inventory holding costs are the same. As noted above, we do not expect stores in practice to reach their maximum capacity levels.

7.2 The Inequality Estimator

Now consider the store's portfolio choice. Take as an example a title t' released by studio s'. Suppose that the store chose a LP contract, but it could instead have chosen not to take the title. We assume that:

$$E\left(\pi_m^{obs}(.) \mid I_m\right) \geq E\left(\pi_m^{alt}(.) \mid I_m\right) \quad (11)$$

for the observed portfolio choice, where π_m^{alt} is defined analagously to π_m^{obs}, but using an alternative portfolio choice, defined below. The expectation is taken conditional on I_m, the store's information set at the time when it makes its choice.[38] We therefore infer from the observed data that:

$$E\left(\pi_m(k_{ms'}^{LP}(t')) \mid I_m\right) \geq E\left(\pi_m(k_{ms'}^{0}(t')) \mid I_m\right) \quad (12)$$

where $k_{ms'}^{LP}(t')$ indicates that the t'th element of $k_{ms'}$ is a LP contract and $k_{ms'}^{0}(t')$ indicates that the title has been dropped. This equation implies the following inequality (assuming that title t' has zero demand by the end of the 4-year period in the data and therefore that the $\rho(.)$ term is differenced out):

$$E\left(\Delta\pi_m^{s',t'}(.) \mid I_m\right) = E\{\sum_s [\sum_{j \in J_s} \{\Delta r_{jm}(k_{ms'}^{LP}(t'), k_{ms'}^{0}(t')) - C(.)\ \Delta\tilde{c}_{jm}(k_{ms'}^{LP}(t'), k_{ms'}^{0}(t'))\} + \Delta\varepsilon_{ms'}] \mid I_m\} \geq 0 \quad (13)$$

Here the difference function $\Delta\tilde{c}_{jm}(k_{ms'}^{LP}(t'), k_{ms'}^{0}(t')) = \tilde{c}_{jm}^{obs} - \tilde{c}_{jm}^{alt} = \tilde{c}_{jm}(k_{ms'}^{LP}(t')) - \tilde{c}_{jm}(k_{ms'}^{0}(t'))$, and similarly for $\Delta r(.)$. The returns from the observed and the alternative portfolios are calculated from the model (even though the observed portfolio return is observed) to ensure comparability in

[37] As a robustness test we could choose alternative portfolios whose end-of-period contracts are the same as those observed in the data. $\rho(\tilde{c}_{ms}, k_{ms})$, like η_m, would then be precisely differenced out of our inequalities. However this would imply dropping a significant proportion of our data on FLF contracts.

[38] We consider only titles that are in release in our data for at least six months.

the counterfactual. Each observed title implies a similar inequality. Similarly, we can consider a switch from not taking a title, to taking it on RS.[39]

We form inequalities for estimation by taking an expectation conditional on the instruments $z_{ms'}$, where s' is the studio whose titles were switched by the store. We define these instruments such that $z_{ms'} \subset I_m$ and $E(\varepsilon_{ms'} \mid z_{ms'}) = 0$. This together with equation (13) implies that:

$$E(\Delta\pi_m^{s',t'}(.) \mid z_{ms'}) = E\left\{ \sum_s \sum_{j \in J_s} \left(\Delta r_{jm}^{s',t'}(.) - C(x_m, x_j, \gamma)\ \Delta\tilde{c}^{s',t'}(.) \right) \mid z_{ms'} \right\} \geq 0. \tag{14}$$

The variables in $\pi_m(.)$ that will change under the alternative portfolio are the indicator functions I_{jm}, prices p_{jtm}, capacities c_{jm}, technology (rentals per tape) τ_{jm}, and contract terms, in the case of adding a title. The terms of the potential RS contracts, (F_j, y^{RS}, u^{RS}), are calculated as the modal values over all stores for that contract type and title[40]. Our assumptions regarding prices and quantities, for both observed and alternative portfolios, are as follows. We note that prices vary only slightly between titles within a store. The average mean 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. The variation is even smaller within contract group. 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 box office class-store-contract type combination being considered.

Similarly, we do not formally model the firm's choice of c_{jm} and τ_{jm} for every title. We define the quantity $\tilde{q}_{tjm}$ as in equation (7). The first term, $Ms_{tjm}(.)$, represents consumer demand for the title in month t. We predict this using the estimated demand coefficients, the other titles offered by the store, and the price and inventory choices for the relevant titles, defined as averages over other titles in the same store-box office class-contract type-month. The inventory level is also constrained by the maximum and minimum quantity restrictions for that title as defined in equation (8)[41]. The last term, $\tau_{jm}\tilde{c}_{jm}$, is the maximum number of rentals the store can offer for this title given the contract type. We interpret this as the store's inventory level for the title under the relevant contract type multiplied by its maximum τ_{jm} (the maximum number of rentals per tape). This maximum τ_{jm} is defined as the 95th percentile of the distribution of τ observed for titles in the same store-box office class-contract type. The inventory level is the same value used as an input into expected demand.[42]

[39] If taking a new title would force the store to hold a total storewide inventory level higher than 110% of that observed for the store in any month in the data, we assume that the store's inventory would equal that maximum cutoff, provided it implies an inventory level for the new title that is above the minimum quantity restriction of the contract; otherwise no inequality is generated.

[40] 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 studios. 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.

[41] We define these values as the modal values for that title and contract type across same-tier stores. If the relevant title-contract-tier group is empty we fill in values using neighboring tiers.

[42] If the store-box-contract group is ever empty we use the minimum number of tapes required by the studio as the expected inventory level for RS and FLF titles. For LP titles we use the average number of tapes per LP title taken by the store for titles in neighboring box office groups. 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 or STP contracts are defined as the maximum of the average prices in the same store-box group under RS, FLF and STP contracts; those for titles taken on RS or FLF contracts (the latter where the store is observed to take the title under a different contract type) are the average of the average

It is worth noting here the distinction between the different methods of forming expectations used in our analysis. When stores choose their contract types, the contract terms (split, upfront fee, wholesale price and maximum/minimum quantity restrictions) are defined by the studio and perfectly observed by the store. We predict expected prices using averages over titles within the same store-box office-contract type-month since there is less variation within-store across titles than there is across stores for a particular title (see Mortimer (2007) for evidence on this).[43] Expected inventory is treated analogously, except that it does not vary by month. Where a title is observed to have zero transactions in a particular month at a store, we follow a methodology consistent with that used in the demand model and exclude these observations.

As noted earlier, we consider first the store's alternative of dropping each title that we observe it to take. This provides an upper bound on the cost of holding inventory. We then add inequalities in which the store adds titles that we observe it not to take: we assume that each new title is added on a RS contract. This provides a lower bound on the inventory holding cost. We estimate inventory holding costs using just these two sets of inequalities.

Consider the inequalities generated by the alternative of dropping titles t' that we observe the store to take. For each t' we calculate $r_m^{altt'}(.) = \sum_s \sum_{j \in J_s} (r_{jm}^{altt'}(.))$, the store's total return when it drops title t', holding all other contracts and inventory levels fixed. The calculation incorporates the revenue from all titles offered by all studios in all years in the data, since changing a single contract may affect demand for other-studio titles, even if these are offered in later months[44]. We generate the equation for estimation by converting the expectations in equation (14) into sample averages over stores[45]. We also average over alternative choices t' in a particular studio-year before interacting with the instruments. This implies the following equation for estimation:

$$\Delta\bar{\pi}_{ys'}^{noFLF} = \frac{1}{M}\sum_m \left((r_m^{obs} - C(.)\ \tilde{c}_m^{obs}) - \frac{1}{Q_{ys'}} \sum_{t' \in (s',y)} (r_m^{altt'} - C(.)\ \tilde{c}_m^{altt'}) \right) \otimes g(z_{ms'}) \geq 0 \qquad (15)$$

where y indexes years, s' indexes studios, $Q_{ys'}$ is the number of titles offered by studio s' in year y, $g(.)$ is any positive-valued function of the instruments, M is the number of stores in the data and $r_{\,m}$ is the sum of r_{jm} over all titles. The total store-level inventory holding cost for a particular set of contracts is written as:

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

We therefore have one moment per studio-year-instrument triple. We exclude studio-years where no titles are offered and average within each year (before taking the store average) over studios that released fewer than five titles during our panel. This generates 56 studio-year moments per

prices under the other three contract types. Finally, in all these cases we define maximum τ as the maximum of the average prices 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 group for neighboring months.

[43] We could have considered titles in the same store-genre-box office-contract type-month, consistent with the nest definitions in the demand model, but encountered problems with small sample sizes in some cases.

[44] In fact the demand framework only allows a change in contract for title j to affect the within-group share and therefore demand for title k in months where they overlap in consumers' choice sets. It seems reasonable to assume that title k's demand in months before j is released will be unaffected by a change in j's contract type, assuming 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.

[45] We stack the inequalities for all regions before taking the average over stores. We therefore estimate a single set of costs for all stores, taking into account all of the region-specific demand estimates from Section 6.

instrument. Our methodology is very similar when the switch is from not taking the contract to taking it on RS, except that we include only titles that were offered on RS contracts, generating 38 studio-year moments per instrument[46]. 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.

We hold the portfolio of titles fixed other than the single change being considered. Of course in reality the store may change both its portfolio of titles offered by this studio and the set of titles taken from other studios when it makes that single change. However, we do not need to model the store's portfolio choices here in order to consistently estimate the inventory holding cost. The simpler inequalities that hold title portfolios fixed are also valid and are sufficient for our purposes. We model portfolio choices in the counterfactual analyses considered below.

In addition, in reality the store is making a dynamic choice. Because each title is active for five months, the optimal contract choice for a title released in month 1 should take into account both the effect of the choice on consumer demand for titles released in months 2-5 and also its effect on the store's choice of contracts for later titles. Our methodology accounts for the former but not the latter effect. Again this will not bias our estimates. The alternative contracts that we consider are feasible for the store; they may not be the optimal alternatives, since only a single contract choice is changed, but all we need is for the inequalities to hold in expectation and this requirement is still satisfied. Our assumption of single-firm markets helps us here: if more than one store existed in each market, each store would need to consider the future reactions of other agents when it changed its contract choice and the inequalities would need to take these predictions into account. Finally, it is worth noting that alternative methodologies such as the multinomial logit model would produce biased estimates when applied to this dynamic situation. This is one reason why we choose to use the inequalities methodology in preference to such alternatives.

The instruments $z_{ms'}$ (defined at the store-studio level) are required to be uncorrelated with $\varepsilon_{ms'}$, the unobservable in the profit equation, and correlated with the capacity chosen by the store. The unobservable includes variation in inventory holding costs and other store costs that is not observed by the store but that will affect its total costs when it alters its contracts with studio s'. It could also include store prediction error regarding the prices for which the store will be able to sell used tapes or of the proportion of tapes that will break before they can be sold. Our instruments include the number of titles released by the studio in the relevant year and the percent of these titles that are from Box Office groups A and B respectively. At the store level we use indicators for stores with a high percent single population, a high percent of the population with children, a high median age and a high number of households, where "high" is defined as above the 75^{th} percentile in the data. We also use indicators for the size of the store's chain.

The inequality method will lead to biased estimates if the unobservable ε_{ms} contains any variables that differ across contract types and are observed by the store. For example, there may be differences in the restrictions placed by studios on stores' sales of used tapes for LP contracts compared to RS and FLF[47]. We do not accurately observe the contract-specific requirements and

[46] When titles are added we assume that the store purchases the minimum number of tapes required by the studio. We define the unobserved quality of the new titles to be the minimum ξ_{jmt} in the store-box-genre-month group. If there are no other titles in this group we use the average in the store-box-month. If no stores took the title in the relevant zip code category we have no δ_{jmt} estimates for that region; we exclude these zipcodes from the counterfactuals for the relevant title. Any unobserved differences between these zipcode categories and the others that might affect the results will be captured in the store fixed effects in the store profit equation.

[47] A title that is obtained on a LP contract will be sold at a price set by the store at the end of its rental life; the store retains 100% of the revenues from these sales. However, if the store obtains a title on a RS or FLF contract it is required to pay a certain proportion of the revenues from used tape sales back to the studio.

therefore cannot control for them in our estimation. It is reassuring to note that sales of used tapes make up a fairly low proportion of each store's revenues, especially for B and C titles. We might also be concerned about the endogeneity of $\bar{c}_{jm}$ and $\underline{c}_{jm}$, both of which are set by the studio on a title-by-title basis. Any unobservable that affects the store's choice of contract for title j may also affect the studio's choice of quantity restrictions. However, many studios choose these quantity restrictions using a formula based on the title's box office sales and the size of the store.

7.3 Results

Our specification for the cost of holding a tape includes three variables: a constant and indicators for box office B and C titles. The results are given in Table 8.[48] The estimate of μ was a singleton: that is, there was no parameter vector that satisfied all the inequality constraints[49]. We report the conservative 95% confidence intervals derived in Pakes, Porter, Ho and Ishii (2007). We estimate a negative cost of \$30.07 of holding each tape of Box Office Group A titles (those with theatrical box office revenues over \$40 million). The "value" of B and C titles (those with box office revenues of \$15-40 million and under \$15 million respectively) is much lower. The estimates imply a value of \$1.36 per tape for B titles and \$14.41 per tape for C titles.

There are several potential sources of a positive value per tape to the store. First, the store generates approximately \$9 of revenues from selling each used tape. Second, unobserved volume discounts, particularly under LP contracts, could reduce the cost to the store of taking tapes compared to the cost used in our analysis. Conversations with industry experts indicate that these discounts are probably approximately 20% of the wholesale price for LP titles, or \$13 per tape on average. Third, adding tapes to the shelf (particularly those for titles in Box Office category A) may increase retailer profits by attracting new consumers to the store.

We estimate that C titles have a higher value per tape than B titles. The reason may be that C movies are often niche or "arthouse" titles which appeal to a particular segment of the population and may therefore be more attractive to consumers - and therefore bring in more revenues to the store from the sale of used tapes and from drawing in customers from the store's competitors - than B titles which are often relatively unsuccessful mainstream movies.

8 Counterfactual Analyses

Our goal in the final stage of the analysis is to conduct a counterfactual that allows us to estimate the welfare effect of FLF contracts. Our informational assumption for estimating the moment inequalities is that each store perfectly predicts the titles to be released in future months but may imperfectly predict consumer demand for these titles and the cost of holding inventory. We require our counterfactual experiment to be consistent with this assumption.

We use our estimates to predict the effect of postponing the implementation of FLF contracts for a subset of the studios in our data. Two of the seven FLF studios in our data implemented FLF early, in month 14 of our panel. The others followed some time later: in or after month 30. We leave the two early implementers unchanged and remove the three earliest months of FLF for the studio that began FLF in month 30. For each store we solve backwards from the last to the first month from which FLF has been removed, considering the choice of which titles to take

[48] These results use the previous iteration of the demand results, which are very similar to the current results for the first geographic region. The code for the remaining regions in the most recent iteration has not yet finished running.

[49] As noted in Pakes, Porter, Ho and Ishii (2007), this does not imply that we should reject the specification. The result could easily 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.

for all studios. Our assumption that each store operates in a separate market implies a unique equilibrium. We obtain a set of sequential choices over titles' contract types that are optimal for the store assuming perfect foresight about the titles to be released in the future, given the observed choices in the data both before and after the three-month counterfactual period.

We hold fixed stores' choices of contract types both before and after our counterfactual. We assume that the removal of FLF was a surprise, so choices made before the removal may not be optimal after the change. Choices made after the counterfactual may in fact be affected by it: for example FLF contracts observed in the data in the first month after FLF is re-instated may have started in earlier months, implying that they should be extended in our counterfactual. In addition, the observed LP and RS contracts in the first few months may not be optimal given the new contract choices during the counterfactual period. We use two alternative methods to address this issue. First we assume that stores make their choices in the belief that FLF will be available from the beginning of the counterfactual onwards. The FLF studios then unexpectedly delay the beginning of the program by three months but hold stores to their commitments to purchases after FLF is reinstated. Other studios also hold stores to these commitments but allow them to re-optimize during the counterfactual period. This latter assumption is probably unrealistic; its effect on our results depends on the extent to which choices in one month are influenced by expected contract types in later periods. Our second counterfactual addresses this by assuming that the non-FLF studios hold stores to their prior commitments throughout the counterfactual period and beyond it. This rules out the leverage effect but may not have much impact on the overall results (particularly given our counterfactual analyses which indicate that the leverage effect is probably small).

Our preliminary results are displayed in Table 9. Five titles were released by the FLF studio during the three-month period of our counterfactual. 56 were released by other studios during the same time period. We consider 144 stores that were directly affected by the counterfactual. We report the results where we rule out the leverage effect. The mean number of titles dropped (out of the 5 FLF titles) is 1.6; the mean numbers of titles switched to LP and RS contracts are 0.3 and 3.1 respectively. This results in a mean store profit decrease for the relevant three months of 2.57%[50]. The FLF studio's profits for the same three months, from the stores included in the counterfactual, fall by 27% in total (assuming a cost to the studio of \$2 per tape)[51]. Other studios' profits increase slightly (by just 0.70%) because some consumers switch from the dropped FLF title, and from those for which inventory has decreased with the change in contract type, to the titles released by other studios. Consumer surplus falls slightly because of the reduction in the size of the choice set. The total effect of delaying the introduction of FLF is a median welfare loss of 1.23% per store.

Our next step will be to include the leverage effect. In order to make the calculation computationally feasible we will restrict the counterfactual to the five titles released by the FLF studio and any other titles in the same box-genre-rating group, released by other studios in the same three-month window, that were not taken by the relevant store. These are the most likely to be affected by the leverage effect. We will then restrict our attention further, to the 112 stores whose choice set contains fewer than 500,000 possible contract type perturbations. Our preliminary results indicate that the leverage effect is likely to be small.

[50] This figure compares the model's predictions for store choices and store profits given the delay in FLF introduction to the model's predictions for store profits given the actual data on store contract choices without the delay. Our next step is to calculate the model's predictions for store contract choices under this baseline scenario for comparison.

[51] If we exclude the stores whose profits increase when FLF is delayed - that is, the stores that lost money from choosing the FLF contract - the studio's profit decrease falls to 20.0%.

9 Discussion and Conclusion

Our preliminary results from the full model are consistent with the reduced form analysis. Store profits fall slightly from the delay in FLF and the FLF studio loses a substantial amount. This loss far outweighs the small gain to other studios. Our preliminary analyses indicate that the leverage effect is likely to be much smaller than the combined market coverage and efficiency effects. We therefore expect our final results to indicate a positive overall welfare effect of FLF contracts (a loss from delaying their introduction). To some extent this is not surprising. The reasonably large number of active studios (59 in our data), each producing only on average 8 titles per year, implies that each studio's power to persuade retailers to exclude other studios is probably quite limited. The finding of a small leverage effect is therefore not unexpected. The market coverage and efficiency effects are both welfare-improving, implying a positive aggregate effect of FLF contracts on welfare. Further study of the welfare effects of bundling contracts, particularly in settings where the upstream firm may have more market power, would be useful.

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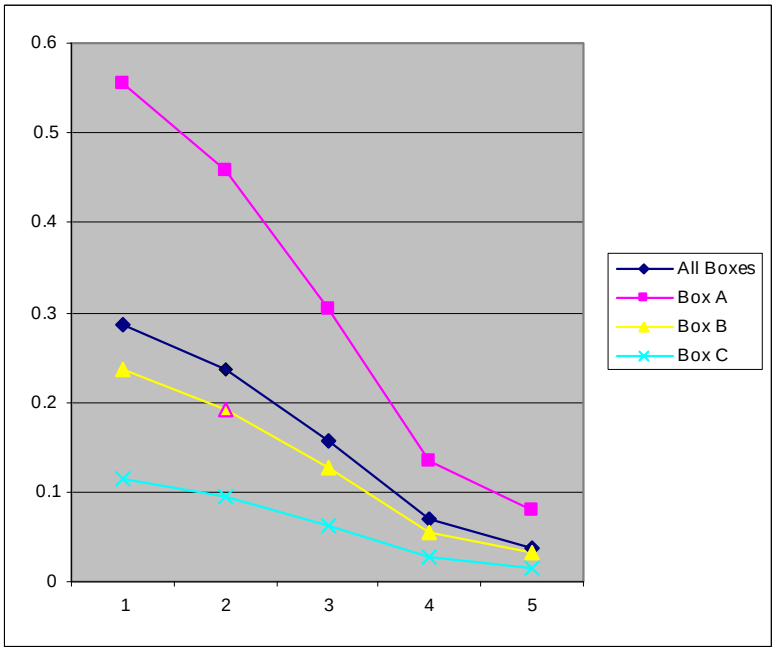
Figure 1: Inventory Elasticities Implied by Demand Estimates



Notes: Elasticities implied by the demand estimates. Corresponding data are given in Table 6. Elasticities with respect to inventory are calculated for every store-title-month observation and then averages are taken within each month.

Table 1: Summary Statistics

Contract	Linear Pricing	Revenue Sharing	Full-Line Forcing	Sell-Through Priced
Avg Terms				
Upfront Fee	66.82	8.48	3.60	15.17
	(5.59)	(1.07)	(1.24)	(1.64)
Retailer's Share of Revenue	100%	45.95%	59.01%	100%
	(-)	(2.98%)	(2.00%)	(-)
Minimum quantity	-	9.64	10.68	-
	(-)	(11.47)	(10.58)	(-)
Maximum quantity	-	23.37	22.28	-
	(-)	(22.59)	(21.44)	(-)
Avg No. of Rentals				
Month 1:	49.58	67.46	52.13	91.01
	(78.47)	(100.7)	(88.39)	(125.5)
Month 2:	64.87	70.38	60.01	83.97
	(90.21)	(100.3)	(80.54)	(100.2)
Month 3:	38.87	35.40	32.39	39.22
	(51.57)	(49.06)	(44.18)	(46.38)
Month 4:	25.13	22.26	20.48	21.94
	(31.77)	(29.73)	(26.73)	(25.16)
Month 5+:	69.54	60.06	57.29	78.73
	(102.8)	(88.53)	(81.13)	(136.0)
Avg Rental Price				
Month 1:	2.67	2.69	2.71	2.71
	(0.61)	(0.52)	(0.63)	(0.58)
Month 2:	2.85	2.80	2.90	2.89
	(0.61)	(0.56)	(0.60)	(0.63)
Month 3:	2.85	2.80	2.89	2.96
	(0.66)	(0.60)	(0.67)	(0.75)
Month 4:	2.85	2.80	2.88	2.97
	(0.70)	(0.64)	(0.70)	(0.86)
Month 5+:	2.82	2.72	2.91	2.98
	(0.74)	(0.70)	(0.76)	(0.90)
Avg Rentals per Tape				
Month 1:	5.63	4.27	4.13	5.13
	(4.42)	(2.89)	(3.13)	(4.73)
Month 2:	7.73	4.78	5.38	5.20
	(4.92)	(3.22)	(3.71)	(3.74)
Month 3:	5.06	2.53	3.38	2.60
	(3.78)	(1.89)	(2.85)	(2.14)
Month 4:	3.56	1.66	2.45	1.61
	(2.94)	(1.33)	(2.41)	(1.66)
Month 5+:	13.52	5.04	7.28	6.82
	(14.32)	(5.07)	(9.00)	(8.84)
Avg Inventory	8.81	14.60	12.53	18.20
	(13.92)	(17.64)	(17.33)	(21.73)

Notes: Average contract terms, rentals, prices, inventories and store sizes for titles taken under each contract type. Averages are across store-title pairs. Standard deviations in parentheses. Data source: Rentrak Corporation, January 1, 1998 to June 30, 2002.

Table 2: Summary Statistics (Cont.)

Contract	Linear Pricing	Revenue Sharing	Full-Line Forcing	Sell-Through Priced
Total No. of Titles Offered by Studios				
Year 1:	219	150	0	27
A Titles:	30	24	0	15
B Titles:	36	25	0	6
C Titles:	153	101	0	6
Year 2:	195	143	10	24
A Titles:	32	30	1	14
B Titles:	40	36	2	6
C Titles:	123	77	7	4
Year 3:	221	173	18	21
A Titles:	41	39	4	15
B Titles:	43	39	3	1
C Titles:	137	95	11	5
Year 4:	195	122	39	26
A Titles:	33	20	9	16
B Titles:	49	23	5	3
C Titles:	113	79	25	7

Notes: Average number of titles offered by studios 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 terms. No Sell-through Priced titles are offered under other contracts. The primary source of data summarized in this table is Rentrak Corporation. Data were gathered from January 1, 1998 to June 30, 2002.

Table 3: Summary Statistics (Cont.)

Contract	Linear Pricing	Revenue Sharing	Full-Line Forcing	Sell-Through Priced
Number of Stores				
	7107	6687	4896	6926
Avg No. of Titles Taken by Stores				
Year 1:	95.86	23.02	-	19.31
	(45.20)	(24.76)	-	(7.81)
A Titles:	19.23	4.88	-	11.58
	(7.70)	(3.58)	-	(4.45)
B Titles:	22.92	4.92	-	4.06
	(10.08)	(5.42)	-	(1.89)
C Titles:	53.71	13.21	-	3.68
	(30.18)	(16.95)	-	(2.00)
Year 2:	68.36	20.11	3.64	14.90
	(44.62)	(21.68)	(3.23)	(7.95)
A Titles:	14.25	7.01	0.37	8.82
	(8.86)	(6.13)	(0.48)	(4.41)
B Titles:	19.67	6.76	1.06	3.85
	(11.90)	(7.61)	(0.96)	(2.42)
C Titles:	34.43	6.34	2.21	2.24
	(25.95)	(9.28)	(2.22)	(1.61)
Year 3:	95.63	18.35	6.04	14.23
	(55.63)	(23.37)	(3.92)	(6.93)
A Titles:	23.05	7.30	1.53	11.09
	(12.38)	(7.31)	(1.01)	(5.31)
B Titles:	25.43	5.23	0.86	0.74
	(13.69)	(7.40)	(0.67)	(0.44)
C Titles:	47.15	5.82	3.65	2.40
	(31.88)	(9.96)	(2.69)	(1.49)
Year 4:	85.38	13.79	10.01	17.22
	(40.80)	(17.41)	(7.35)	(7.51
A Titles:	19.60	5.56	3.27	12.11
	(9.10)	(5.32)	(2.10)	(5.02)
B Titles:	32.07	3.54	0.97	2.06
	(13.77)	(5.27)	(0.99)	(1.30)
C Titles:	33.71	4.69	5.77	3.05
	(20.41)	(7.73)	(4.69)	(1.64)

Notes: Average number of titles of each contract type taken by all active stores in each year, where stores not participating in a contractual form in a given year are listed with zero titles. Standard deviations in parentheses. The primary source of data summarized in this table is Rentrak Corporation. Data were gathered from January 1, 1998 to June 30, 2002.

Table 4: Summary Statistics (Cont.)

Contract		Linear Pricing	Revenue Sharing	Full-Line Forcing	Sell-Through Priced
Ave store tier					
Quintile 1		2.52	5.24	2.91	4.75
Quintile 2		3.07	4.94	4.18	4.64
Quintile 3		3.46	3.16	4.47	4.03
Quintile 4		4.83	3.01	4.01	2.91
Quintile 5		5.11	2.70	4.54	2.31
Quintile	% of quintile				
1	Tier 1-3	1.35	0.22	1.19	0.62
	Tier 7-10	0.20	1.13	0.24	1.50
2	Tier 1-3	1.13	0.50	0.63	0.48
	Tier 7-10	0.33	1.39	0.60	0.99
3	Tier 1-3	0.99	1.10	0.57	0.68
	Tier 7-10	0.50	0.38	0.93	0.43
4	Tier 1-3	0.38	1.16	0.79	1.17
	Tier 7-10	0.88	0.33	0.82	0.38
5	Tier 1-3	0.43	1.30	0.62	1.41
	Tier 7-10	1.56	0.42	1.06	0.09

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 size in each quintile. Tiers are ranked from 1 to 10 where 10 is largest. Panel 2 reports the percent of stores in each quintile of percent of titles adopted under a particular contract type that are in store sizes 1-3 and 7-10 respectively. These numbers are normalized by the percent of all stores that are in the relevant set of tiers. Numbers over 1 indicate that this type of store is over-represented in the relevant quintile for this contract type. The primary source of data summarized in this table is Rentrak Corporation. Data were gathered from January 1, 1998 to June 30, 2002.

Table 5: Demand Results

	OLS	IV 1	IV 2
	Coefft (S.E.)	Coefft (S.E.)	Coefft (S.E.)
Price	-.027 (.002)	-.026 (.003)	-.024 (.003)
Month 2	.131 (.022)	.154 (.024)	.137 (.025)
Month 3	-.137 (.022)	-.191 (.025)	-.207 (.025)
Month 4	-.399 (.023)	-.505 (.025)	-.512 (.026)
Month 5+	.192 (.024)	.277 (.027)	.285 (.027)
Inventory	.0187 (.0003)	.0210 (.0004)	.0160 (.0005)
Inv*Month 2	-.003 (.0004)	-.004 (.0005)	-.003 (.0005)
Inv*Month 3	-.008 (.0004)	-.009 (.0005)	-.008 (.0005)
Inv*Month 4	-.012 (.0004)	-.013 (.0005)	-.013 (.0005)
Inv*Month 5	-.011 (.0004)	-.013 (.0004)	-.014 (.0005)
σ	.631 (.002)	.497 (.003)	.500 (.003)
N	405831	405831	405831
R^2	0.82	0.76	0.76

Notes: Results of nested logit demand analysis. IV1 instruments for the within-group share only. IV2 instruments for both within-group share and inventory. All specifications include title and store fixed effects, interactions between title fixed effects and store characteristics (the percent in the market with kids, the percent single and the percent white) and interactions between month fixed effects and title characteristics (the box office group, genre, rating and interactions of these variables).

Table 6: Demand Results: Elasticity Estimates

	Month 1	Month 2	Month 3	Month 4	Month 5
All Box Office groups:					
Price elasticity	-0.114	-0.120	-0.126	-0.130	-0.119
Inventory elasticity	0.287	0.236	0.157	0.069	0.037
Box Office Group A:					
Price elasticity	-0.115	-0.121	-0.130	-0.135	-0.129
Inventory elasticity	0.556	0.459	0.304	0.135	0.079
Box Office Group B:					
Price elasticity	-0.113	-0.117	-0.124	-0.128	-0.119
Inventory elasticity	0.237	0.191	0.127	0.056	0.032
Box Office Group C:					
Price elasticity	-0.115	-0.121	-0.124	-0.126	-0.113
Inventory elasticity	0.115	0.096	0.062	0.027	0.014

Notes: Elasticity estimates implied by the demand estimates. Demand elasticities with respect to price and inventory are calculated for every store-title-month observation and then averages are taken within each month.

Table 7: Demand Results: Second Stage Regressions

	OLS Coefft (S.E.)	IV 1 Coefft (S.E.)	IV 2 Coefft (S.E.)
Release date:			
Quarter 2	-0.008 (0.004)	-0.011 (0.004)	-0.015 (0.004)
Quarter 3	-0.118 (0.004)	-0.120 (0.004)	-0.123 (0.004)
Quarter 4	-0.029 (0.004)	-0.041 (0.004)	-0.043 (0.004)
Box Office:			
B	-0.745 (0.042)	-0.685 (0.044)	-0.725 (0.045)
C	-1.360 (0.039)	-1.277 (0.041)	-1.316 (0.042)
Genre:			
Child/Family	-0.772 (0.051)	-0.589 (0.052)	-0.628 (0.051)
Comedy	0.187 (0.046)	0.277 (0.047)	0.262 (0.046)
Drama	-0.133 (0.023)	-0.068 (0.073)	-0.095 (0.023)
Horror/Suspense	-0.021 (0.031)	-0.023 (0.033)	-0.037 (0.034)
Romance	-0.814 (0.045)	-0.657 (0.046)	-0.684 (0.046)
Science Fiction	-0.722 (0.053)	-0.551 (0.056)	-0.533 (0.056)
Rating:			
PG	-0.020 (0.032)	0.027 (0.032)	0.044 (0.032)
PG13	0.067 (0.053)	0.183 (0.054)	0.210 (0.053)
R, NC17, NR	0.011 (0.059)	0.130 (0.060)	0.139 (0.060)
Market characteristics:			
Median age	0.007 (0.001)	0.008 (0.001)	0.006 (0.001)
Median income	-0.011 (0.0002)	-0.011 (0.0002)	-0.012 (0.0002)
Number of households	-7.1e-5 (3e-7)	-7.2e-5 (4e-7)	–7.1e-5 (4e-7)
Percent white	-0.029 (0.0004)	-0.029 (0.0004)	-0.030 (0.0005)
Percent black	-0.024 (0.0004)	-0.023 (0.0004)	-0.025 (0.0004)
Percent female	0.016 (0.002)	0.013 (0.002)	0.021 (0.002)
Percent single mother with kids	0.006 (0.001)	0.006 (0.001)	0.008 (0.001)
Percent single father with kids	-0.258 (0.004)	-0.254 (0.004)	-0.256 (0.004)
Percent single male	-0.374 (0.008)	-0.375 (0.008)	-0.371 (0.008)
Percent single female	-0.034 (0.004)	-0.037 (0.004)	-0.035 (0.004)
Percent married with kids	0.020 (0.001)	0.019 (0.001)	0.023 (0.001)
Percent with Bachelor's	-0.012 (0.0003)	-0.012 (0.0003)	-0.011 (0.0003)
Blockbuster in market	0.670 (0.003)	0.670 (0.004)	0.674 (0.004)
Percent rural	0.005 (0.0002)	0.0004 (0.0002)	0.0007 (0.0002)
Percent suburban	-0.001 (0.0001)	-0.001 (0.0001)	-0.001 (0.0001)
N	405831	405831	405831
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.

Table 8: Inequalities Analysis Results

	Coefft (S.E.)	95% Conservative CI
Per Tape:		
Constant	-30.07	[-30.53, -29.99]
Box B title	28.71	[28.61, 29.10]
Box C title	15.66	[15.63, 16.50]

Notes: Results of inequalities methodology to estimate stores' costs of holding inventory. 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.

Table 9: Counterfactual Analysis Results

		No leverage
Change in number titles taken per store		dropped / LP / RS
	mean	1.6 / 0.3 / 3.1
Baseline store profits		
	mean	$15,269
Baseline FLF studio profits		
	total	$51,473
Baseline other studio profits		
	total	$1,409,400
% Change in store profits		
	mean	-2.57%
% Change in FLF studio's profits		
	total	-27.27%
% Change in all other studio profts		
	total	0.70%
% Change in consumer surplus per store		
	mean	-0.91%
% Total welfare change per store		
	mean	-1.23%

Notes: Results of counterfactual analyses. Introduction of FLF contracts was delayed by three months for a single studio. That studio released 5 titles in the relevant window. 56 titles were released by other studios in the same period. 144 stores are considered in each counterfactual.