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Revenue Sharing and Vertical Control In the Video Rental Market*

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ABSTRACT

Revenue sharing contracts, in which retailers pay a royalty on their sales to their suppliers, are now widely used in video rental retailing. This paper argues that revenue sharing is a valuable instrument in vertically separated industries when there is intrabrand competition among the downstream firms, demand is stochastic or variable, and downstream inventory is chosen before demand is realized. In these environments, the upstream firm would like to simultaneously soften downstream competition and encourage efficient inventory holding. Two-part tariffs are unable to achieve both objectives in the presence of downstream competition. Raising the unit price of the inputs above marginal cost softens retail price competition but distorts retailers' inventory decisions. We show that revenue sharing, combined with a low input price, aligns the incentives in the vertical chain.

1. Introduction

Many supply contracts in vertically separated industries include revenue-sharing agreements where the downstream firms make royalty payments to the upstream firm based upon the downstream sales revenue.[1] These output-based payments are often used in addition to direct payments for the inputs in the downstream production process. This paper argues that revenue sharing is a valuable instrument in vertically separated industries when there is intrabrand competition among the downstream firms, demand is stochastic or variable, and downstream inventory is chosen before demand is realized. In these environments, the upstream firm would like to simultaneously soften downstream competition and encourage inventory holding. Traditional two-part tariffs are unable to accomplish both. Raising the price of the inputs softens downstream price competition but distorts the downstream firms' inventory decisions. We argue that revenue sharing, combined with a low input price, aligns the incentives in the vertical chain.[2]

The video rental industry provides a recent illustration of this idea. Many Hollywood movie studios have been changing the way they do business with video retail outlets. Traditionally, retailers like Blockbuster Video bought recently released videotapes through a distributor for about $65 a copy and would keep all of the revenue from the subsequent rentals. Under this old system, customers were frequently "stocked-

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[1] These clauses might specify a percentage share (royalty) of the downstream firms' revenues or a fixed price per unit sold. While we focus on percentage shares in our models, analogous results are obtained for fixed prices.

[2] Many examples of revenue sharing appear in the literature, including sharecropping (Allen and Lueck, 1993), contingent fees for attorneys (Dana and Spier, 1993, and Rubinfeld and Scotchmer, 1998), franchising (see Bhattacharrya and Lafontaine, 1995, and the references therein), and licensing (see Shapiro, 1985, Gallini and Wright, 1990, and Beggs, 1992). A variety of rationales for these arrangements have been proposed,

out" and would either substitute towards a less popular title or would go home empty-handed. Under the newer system, videos are purchased by rental outlets for about $8 each and the rental revenue is shared: Blockbuster keeps 45% of the revenue,[3] the movie studio gets 45%, and the remaining 10% goes to Rentrak, Blockbuster's distributor.[4] Under these revenue sharing deals, Blockbuster has increased its inventories of recent releases seven fold, and has launched a successful "Go Home Happy" marketing campaign, in which customers are guaranteed that a select list of videos will be in stock.[5]

The ideas here are related to other work on vertical contracts. Warren-Boulton (1974) and Mallela and Nahata (1980) showed that when the factors of production are variable and downstream markets are competitive the upstream firm faces a tradeoff between softening downstream competition and inducing downstream firms to combine inputs efficiently. While two-part tariffs that set the transfer price above marginal cost soften downstream competition, they also lead to wasteful input distortions. Warren-Boulton (1974, 1977) argued that revenue sharing, together with marginal cost transfer pricing, solves both the input and the output distortions and implements the vertical integration outcome.

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including two-sided moral hazard, risk allocation, capital constraints, price discrimination, and signaling.

[3] In September of 2000, Rentrak's contracts allow video outlets to retain 55% to 60% of the rental revenues and pay $0 to $5 per video tape. For details of these contracts see http://www.newppt.com/, September 2000.

[4] Retailers typically must pay a high price, $67 for example, for any video that they report lost or stolen within 60 days of release. After the 60 days elapse, the retailer typically can resell the used videos. "Rentrak Asks Retailers: Want a Bigger Cut?" *Video Business*, July 20, 1998. More recently, Blockbuster Video, Hollywood Video and other large retailers have bypassed Rentrak and are doing business directly with the movie studios. The retailers can also obtain DVD's under the same system. A similar system has been adopted for CD-ROM rentals. See "Comptons Tries Revenue Sharing for CD-ROM," *Billboard*, January 29, 1994.

Another related problem is the one an upstream monopolist faces when selling a patented technology or licensing a brand name to downstream competitors. Selling indivisible know-how to competitive downstream firms at a fixed price would lead them to dissipate rents, while a royalty on sales softens downstream competition and implements the collusive outcome (see Shapiro, 1985, and Schmidt, 1994).

The most closely related work is the literature on vertical restraints and demand uncertainty. Kandel (1996) and Marvel and Peck (1995) show that a monopolist selling to a single downstream firm can use a returns policy (or buybacks) to profitably increase downstream firms' inventory holding when demand is uncertain, prices are flexible, and two part tariffs are infeasible.[6] Padmanabhan and P'ng (1997) derive similar results in a model with two downstream firms.[7] With downstream competition, returns policies are desirable even if lump sum transfers are feasible. Deneckere, Marvel, and Peck (1997) and Butz (1997, 1998) show that minimum resale price maintenance profitably limits retail price cutting when retail prices are flexible and demand is uncertain because like a returns policy, it prevents competing retailers from cutting price to sell all their inventory when demand is low. Deneckere, Marvel, and Peck (1996) show that resale price maintenance also profitably increases downstream firms' inventories when prices are inflexible and demand is uncertain (so stock-outs may occur).[8]

Each of these literatures shares two common themes. First, the upstream firm wants to control more than one dimension of the downstream firms' behavior (such as

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[5] See Furman (1998).
[6] See also Pasternack (1985) and Emmons and Gilbert (1998).
[7] Their contract does not achieve the vertical integration outcome because they prohibit lump sum transfers.
[8] See also Scotchmer (1987).

retailers' inventory levels or downstream firms' input mix and the downstream price). Since control of every dimension of behavior cannot be achieved with a simple two-part tariff, the upstream firm may benefit from adopting vertical restraints.[9] The second theme is downstream competition. In the absence of intrabrand competition, the upstream firm could "sell the assets" to a single downstream firm, which would directly give it the incentive to implement the vertical integration. As is typical in the literature, we assume that the upstream firm must contract with every downstream firm.[10]

In this paper we extend the theoretical literature on vertical restraints and demand uncertainty in two ways. First we show that revenue sharing contracts operate much like returns policies. When prices are not flexible, revenue sharing induces downstream firms to hold more inventories without softening price competition. When prices are flexible, revenue sharing limits destructive price competition during periods when demand is low. Second, we show that these vertical restraints coordinate the vertical chain in two environments not previously considered by the literature on vertical restraints: (i) when downstream competition is characterized by "competitive newsboy model" proposed by Carlton (1978) and extended by Deneckere and Peck (1995), and (ii) when demand for renting a capital good is declining over time inventory must be set in advance (but prices clear the downstream market).

The paper is organized as follows. Section 2 of the paper provides a detailed description of the video rental industry, the primary application of our models. Section 3

[9] In the case of an indivisible good, like know-how or brand, the upstream firm does not even have the transfer price, so some form of vertical restraint is necessary just to induce the optimal price. See Shapiro (1985) and Schmidt (1994).

presents a model in which demand is uncertain and downstream firms choose both prices and inventories before demand is known. Consumers visit a single firm and buy if the good is available at a price below their reservation value. This model captures the idea that there is a great deal of uncertainty about how popular a new title will be and prices do not fully adjust to market conditions. Section 4 presents a model in which demand is predictable and certain but demand is declining over time and retailers' prices clear the market. Here, the upstream firm faces the problem of preventing destructive price competition during times of low demand. In other words, the firm would like to commit downstream firms to destroy their inventories or waste their capacity. This model extends the work of Deneckere, Marvel, and Peck (1997) where demand is uncertain and the upstream firm attempts to control the price for more than one realization of demand by using resale price maintenance. Section 5 compares the different vertical restraints available to movie studios and suggests why revenue sharing is, and should be, the dominant contract used. The final section discusses other applications, including supply contracts in manufacturing, and offers concluding remarks.

2. The Video Rental Industry

Formed shortly after video cassette recorders were introduced for the home market, the video rental industry grew rapidly through the early 1990's. By 1999, video rentals generated $8.1 billion and video sales generated $9.2 billion in domestic retail revenues.[11] About half of the overall US video rental and sales revenue went to the

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[10] Because the optimal revenue sharing contract implements the vertical integration outcome, this assumption does not impose a cost on the upstream firm. This assumption is discussed in more detail in Section 4.

[11] Interestingly, movie studios were initially opposed to releasing their movies to the home video market, especially the rental market, yet today the video market is their

movie studios, although their share of the consumer rental spending was only around $2.4 billion. Overall, the video market generated more than half of the studios' domestic film-related revenue, much more than the $3.6 billion generated from the domestic box-office in 1999.[12]

Nine major movie studios produced most of the movies in the $7.4 billion dollar domestic film industry. Disney's Buena Vista and Time Warner's Warner Brothers were the box office leaders in 1999 with 17% and 14% market shares respectively.[13] Time-Warner (including its Warner Brothers, New Line Cinema and Home Box Office subsidiaries) and Disney (including its Buena Vista and Miramax subsidiaries) were also the rental market leaders with 21.5% and 19.2% market shares of consumer rental spending respectively.[14] The other seven major studios in decreasing order of box office market share were Universal, Twentieth Century Fox, Paramount, New Line Cinema, Sony (including Sony Pictures and Columbia TriStar), Dreamworks, and MGM. Smaller independent movie studios such as USA Films (including Polygram), Artisan, and Miramax had domestic box office of receipts on the order of $100 million or more. Although these figures suggest that the market is not concentrated, the studios' products are so highly differentiated that they are able to charge substantial markups on their products. However competition in the number and quality of films is intense, so the studios must work hard to produce titles whose gross margins cover the production costs.

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largest source of revenue. See Varian (forthcoming) for a discussion of the optimal pricing of products that consumers share.

[12] The industry statistics are reported in "An Annual Report on the Home Video Market, 1999," Video Software Dealers Association. In 1999, total rental spending increased slightly, even though the number of rental transactions actually fell slightly.

[13] Variety, 377 (8): p. 9, January 10, 2000.

[14] Hollywood Reporter, CCCLXI (17): p. 49, January 17, 2000.

While videos are sold through many channels including pharmacies, warehouse clubs, and mail order, most of the 3.1 billion rental transactions are conducted through 25,000 to 30,000 specialty video rental outlets. Taken together, the top 10 national chains operated 8,600 stores (roughly 1/3 of the total) and had rental revenues of $3.9 billion, about 47% of consumer rental spending. Blockbuster Video, with 4,790 domestic outlets in 1999 (roughly 1/6 of the total), is the market leader in the US and accounts for approximately $2.4 billion, or 30%, of the total rental revenues.[15] In the last few years, rental spending has shifted towards the large, high-volume stores of the national chains. About 1400 video specialty storefronts closed in 1999, and the two largest chains, Blockbuster Video and Hollywood Video, added roughly 1,000 new storefronts.[16]

Video retailers engage in both price and non-price strategies to manage the high demand and weekly demand variation for newly released titles. Many retailers charge a higher price for newly released films which subsequently falls by 50% or more once the title is moved from the new release display to the standard library. Some outlets also offer discounts or 2-for-1 specials on mid-week rentals. Still other outlets keep the price the same, but have shorter rental periods for the newer (and hence more popular) titles.

Despite these basic strategies to manage consumer demand, "stock-outs" are an everyday reality in the industry. According to a Time Warner survey, 20% of customers were unable to rent their preferred video on a typical trip to the video store. Michael Johnson, the president of Buena Vista, Disney's video division, said "It is like going into

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[15] "An Annual Report on the Home Video Market, 1999," Video Software Dealers Association. After Blockbuster, the top four retailers are Hollywood Video (1615 outlets), Movie Gallery (954 outlets), Video Update (641 outlets) and West Coast Entertainment (362 outlets).

McDonald's, asking for your burger and getting French fries."[17] Stock outs are a big concern for retailers since more than two thirds of video rental transactions at large national chains are new releases and an even higher fraction of their revenue.[18] Because a growing number of customers leave the store empty handed when they cannot get one of their first choices, this implies that there is a great deal of consumer value to be captured through business strategies that can increase availability and reduce stock-outs.[19] Revenue sharing is one such strategy, and Rentrak, a video distributor, is credited with its introduction in 1986.

Video cassettes are distributed by intermediaries, many of whom also offer financing, inventory management systems, and promotional materials to the video outlets. Because they sell information systems and equipment to the video stores, distributors are in a unique position to monitor retailers' rental transactions – a crucial technology for implementing revenue sharing. Revenue sharing may have initially appealed to retail outlets as an alternative to financing inventory. However, Rentrak and the movie studios realized quickly that revenue sharing allowed stores to increase inventory, or copy depth, and generate more system wide profits. "Satisfy more customers during the critical first 30 days of a new release" and "bring in 3 to 5 times more hit titles at a low onetime cost …" are just two of 10 reasons Rentrak gives its

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[16] "An Annual Report on the Home Video Market, 1999," Video Software Dealers Association.
[17] Shapiro (1998).
[18] Roughly 67% at one Blockbuster Video outlet located on Chicago Avenue in Evanston, IL, and 70% at a Hollywood Video outlet located nearby.
[19] On hypothesis is that in the 1980's consumers saw many older movies that they still wanted to see, while in the 1990's consumers perceive that there are fewer older movies worth seeing that they have not seen.

customers to adopt its revenue sharing program.[20] In early 2000, Rentrak's "PPT" system (pay per transaction) was used by over 10,000 video outlets, including 8 of the top 10 retail chains. [21] The biggest boost to Rentrak and revenue sharing came in 1998 when Blockbuster Video signed a revenue sharing agreement with Rentrak. Since then Blockbuster Video and Hollywood Video have written revenue sharing contracts directly with the video outlets ,[22] and other video cassette distributors have announced that they will also offer revenue sharing.

"Copy-depth" programs other than revenue sharing are also available to retailers. These offer volume discounts to those retailers who increase their video cassette purchases by 50% to 100% (i.e., meet minimum orders). Rentrak (a potentially biased source of information) suggests that these copy depth programs cost outlets an average of $45 per cassette, as compared to $70 or more for the traditional cassette.[23] In many cases the outlets are required to return much of their inventory once the new release period is over (90 to 120 days).

Current copy-depth programs, including revenue sharing contracts, usually include minimum order quantity and studio product line requirements. Consider, for example, a video outlet with monthly rental and used-tape sales revenue over $20,000 that participated in a revenue sharing agreement with Rentrak for Twentieth Century Fox's videos in September 2000. Under the terms of the contract, this outlet must carry

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[20] These quotes were taken from Rentrak's "Pay-Per-Transaction" revenue sharing program web site at http://www.newppt.com/ in September 2000. Comparison to the report of a seven-fold increases in copy depth at Blockbuster (cited earlier) suggests that some of Blockbusters increase is due to their "guaranteed to be there" marketing.

[21] See http://www.newppt.com/ in September 2000.

[22] Blockbuster has also entered into joint market agreements with the major studios in which Blockbuster ads include previews of individual titles.

at least 15 copies of any Fox title which had box office revenues over $20 million and 38 copies of any Fox title which had box office revenues over $80 million. The outlet pays $5 for each Fox video in addition to a 45% revenue share or $1.20, whichever is greater.[24]

Copy depth programs, and in particular revenue sharing, are viewed as largely successful.[25] One study showed that that store-wide rental transactions increased by 8% when the store adopted store-wide copy-depth programs for many new releases. The study also found that mid-sized retailers who doubled inventory of a particular title increased rentals *of that title* by 19%.[26] These numbers imply that copy depth programs stimulate new sales rather than simply shifting demand towards the newer titles. These new sales can come from two sources. First, the outlet may serve customers under the copy-depth program that would have gone home empty handed otherwise, i.e. customers would not have substituted to an alternative title. Second, the outlet may attract existing customers to visit more frequently (and other customers to switch providers) because the store is offering increased availability. Assuming that the former effect is larger, these

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[23] See http://www.newppt.com/ in September 2000.

[24] See the Fox addendum to Rentrak's Pay Per Transaction agreement on http://www.newppt.com/ in September 2000. Fox also collects 45% of the sales price of any used cassettes (subject to a dollar minimum of $3.60 or $5.20 depending on whether box office sales exceeded $40), however the retailer agrees not to sell any title until 90 days after it is released and then to sell them only to consumers and only through its rental outlet. At the end of the lease period (26 weeks) the outlets return their unsold cassettes to Rentrak or pay an additional buy-out fee of $5.00 ($3.00 if the title had low box office sales) for Fox cassette they wish to keep.

[25] The rental market grew significantly, from $7.4 to $8.1 billion, in 1998 after a decline from 1996. Much of that increase has been attributed in trade journals to large scale adoption of revenue sharing and other copy depth programs.

[26] From a study reported in "An Annual Report on the Home Video Market, 1999," Video Software Dealers Association.

figures suggest that many consumers do in fact leave the store empty-handed when movies stock out.

In addition to changes in the structure of video contracts, there have also been changes in video retailers' marketing strategies. After adopting revenue sharing in early 1998, Blockbuster has explicitly marketed greater availability and emphasized inventory of new releases rather than product breadth. Their "guaranteed to be there" slogan and use of Michael Jackson's "I'll Be There" hit single seems to have been widely successful.

Blockbuster's marketing claims appear to be quite valid. In May 2000, we surveyed the availability of four new releases at 20 video outlets within a 4-mile radius of Northwestern University and found that Blockbuster Video was more likely to have particular new releases in stock than other major chains.[27] Specifically, Blockbuster Video charged $3.81 and had 86% availability. The outlets from other national chains charged $3.32 on average and had 60% availability, while the independent stores charged $2.62 and had only 48% availability. These price differences reflect the fact that Blockbuster has increased its new-release prices since adopting revenue sharing.[28]

While Blockbuster Video emphasizes availability, other video chains have adopted a different focus. Hollywood Video, for example, emphasizes convenience by offering 5-day rentals on all its titles, including new releases. One internet retailer, kozmo.com specializes in home delivery of video rentals (and other goods) in a few

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[27] The survey was conducted on two Saturday afternoons. Two of the four titles were "guaranteed" to be available at Blockbuster Video. The availability of "guaranteed" titles was slightly higher but not 100%.

[28] In 1997, before the adoption of revenue sharing, Blockbuster recent releases rented for $2.99 or less. After the adoption of revenue sharing in 1998, the prices rose to $3.49 and higher. See David Altaner, "A New Approach To Video Rental; Blockbuster To Reward Fast Returns Of New Titles," *Sun-Sentinel* (Fort Lauderdale, Fl), November 22, 1997.

dense metropolitan areas. Other retailers specialize in particular customer segments, such as adult, ethnic, or family titles, or emphasize a knowledgeable staff. Many of these smaller outlets argue that the existing copy-depth programs are not suitable (or too expensive) for them given their emphasis on selection and convenience over availability. To the extent that some of these "boutique" video retailers are not positioned to serve the mass market, they may have more predictable and steady demand. Our model predicts that these environments are not as conducive to revenue sharing.

3. Inventory Holding with Demand Uncertainty and Sticky Prices

In this section we consider an upstream firm that sells a good to downstream firms who then resell it or rent it for one period. We closely follow Deneckere and Peck's (1995) version of Carlton's (1978) model, but we consider "perfect" rather than imperfect competition. The upstream monopolist offers a contract $\{t, r\}$ to the competitive downstream firms, where t is the transfer price per unit of the good and r is the royalty rate on total revenue. Although we focus on royalty contracts as *a percentage of revenues*, it is straightforward to show that analogous results exist for contracts where the royalty is *a fixed price per unit of output*. We do not introduce lump-sum transfers because lump sum transfers would never be used here.[29]

The upstream monopolist produces and sells to the downstream firms before demand is known. The monopolist's cost of production is $c > 0$ per unit of output and the downstream firms' cost of reselling or renting the good is $d > 0$. The latter cost is incurred for each unit of the good that is rented or sold but not for units that remain on the shelves. The downstream firms' marginal cost of stocking the good is normalized to

zero.[30] The downstream firms sell to a uncertain homogeneous customers with unit valuation $V > d + c$. The number of active consumers, x, is a random variable drawn from a distribution with strictly positive probability density $f(x)$ on the support $[\underline{x}, \bar{x}] \in \Re^+$. Let $F(x)$ denote the cumulative distribution function and $E(x)$ denote the mean. Although consumers do not *directly* observe the state of demand, they do draw rational inferences from being active in the market.

The timing is as follows. Before the state of demand is known the downstream firms simultaneously decide how many units to purchase given the contract and set their prices. Prices are assumed to be "sticky" – they cannot subsequently adjust to market conditions. Next, demand is realized and consumers update their beliefs and decide where to shop on the basis of price and expected availability. Once in a store, a consumer will purchase an available unit if and only if his valuation, V, exceeds the price, P.[31] If a customer goes to a store that is out of stock, the customer will "go home unhappy" – there is no opportunity to search further after the initial round.[32]

We believe that this model captures some important features of the video rental

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[29]No firm would be willing to pay an up front fee because the downstream market is perfectly competitive and all downstream rents are dissipated in equilibrium.

[30] If there were a positive cost of holding inventory the model would predict that the monopolist would pay the retailers for each unit stocked.

[31] This model could be generalized to consider homogeneous consumers with downward sloping demands, although social welfare considerations would no longer be straightforward. With heterogeneous consumers, however, the analysis would be significantly more complicated and the equilibrium would feature price dispersion (see for example, Dana, 1999).

[32] This assumption of infinite search costs simplifies the analysis. If we allowed additional rounds, then firms could specialize in high price/high availability, and the equilibrium would be in mixed strategies. Alternatively, we could have specified a model where consumers had zero search costs. In that case, downstream competition would yield price dispersion. First described by Prescott (1975) and extended in Dana

industry. First, demand is uncertain. When a new title is released, it is not entirely clear how popular it will be in the rental market, either nationally or locally. Therefore video retailers make stocking decisions before demand is known. Second, prices are at least partially rigid. Typically, "new releases" are more expensive than "library" titles, but all "new releases" have the same price.[33] Finally, many consumers do have high (if not infinite) search or transactions costs. Once a consumer walks into a Blockbuster outlet it is likely that he will either rent a movie there or go home empty handed.[34] Other assumptions are discussed in greater detail at the end of this section.

Following the literature, we characterize uniform price equilibria where the downstream market supplies K units of capacity at a market price $P \leq V$. In equilibrium, the expected number of units sold as a function of K is:

$$S(K) = \int_0^K xf(x)dx + \int_K^\infty Kf(x)dx. \qquad (3.1)$$

If the number of consumers in the market, x, is smaller than K, then x units will be sold. If, on the other hand, demand outstrips available capacity, $x > K$, then there will be rationing (a "stock out") and K units will be sold. An implicit assumption here is that consumers are very small relative to firms and are evenly distributed among them so in equilibrium either all of the firms stock out or none of them do. Differentiating this expression,

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(1999), this model is used in Deneckere, Marvel and Peck's (1996) model of resale price maintenance and would yield very similar results here.

[33] Video outlets retain some implicit price flexibility through their choice of when to move a video from the "new release" shelf to the "library" shelf.

[34] Some chains do allow customers to reserve titles over the phone, however many customers do not know what their most preferred video is until they are actually in the store and see which titles have been released.

$$S'(K) = 1 - F(K) < 1. \qquad (3.2)$$

When capacity increases by one unit, the expected sales increase by less than one unit. Intuitively, this is because the marginal unit will only sell when demand is sufficiently high, $x > K$, which happens with probability $1 - F(K)$. The probability $1 - F(K)$ is often referred to as the firm's "stock out rate" – the probability that demand will exceed the available supply.

As a benchmark, we first characterize the outcome, *{P*, K*}*, that creates the greatest total value in the vertical chain. A vertically integrated structure would choose P^* and K^* to maximize profits, $(P - d)\,S(K) - cK$, subject to the constraint that consumers are willing to purchase the good, or $P \leq V$. Clearly this constraint binds, so the price extracts the entire consumer surplus,

$$P^* = V. \qquad (3.3)$$

Differentiating the total profits with respect to K and using (3.2), we see that capacity expands to the point where

$$(V - d)\,[1 - F(K^*)] - c = 0\ . \qquad (3.4)$$

In other words, a vertically integrated firm sets the expected marginal return from an additional unit of capacity, $(V - d)[1 - F(K^*)]$, equal to the marginal cost of capacity, c.

Notice that this vertical-integration outcome, *{P*, K*}*, also maximizes social welfare since the expected social return from an additional unit of capacity is precisely $(V - d)\,[1 - F(K^*)]$. This property arises because consumers have unit demands (so there is no consumer dead-weight loss) and the monopolist extracts the entire consumer surplus.

Let us now return to the case of vertically separated firms. Specifically, after the upstream firm announces the contract *{t, r}*, each downstream firm independently and simultaneously chooses how much capacity to purchase and what price to offer it at. Consumers then observe each firm's capacity and price and learn whether they want the good, but not aggregate demand. If they want the good they choose which firm to visit and purchase one unit of the good if it is available at a price less than their valuation. Since consumers can visit only one firm they care about both price and expected availability, and opt to visit firms that offer the best combination. In a uniform price equilibrium, a consumer's probability of being served (conditional upon his being active in the market), also known as the "service rate," is equal to the total expected sales divided by the expected number of consumers:[35]

$$R(K) = \frac{S(K)}{E(x)}. \tag{3.5}$$

The representative consumer's expected surplus conditional upon being in the market, is the consumer surplus conditional upon purchasing the good, $V - P$, multiplied by this service rate, *R(K)*, or

$$U(P,K) = (V - P)\frac{S(K)}{E(x)}\ . \tag{3.6}$$

A competitive equilibrium is a price and inventory, $\{\tilde{P}, \tilde{K}\}$, and an allocation rule for consumers defined over pairs of prices and inventories $\{\{P_1, K_1\}, \{P_2, K_2\}\}$, such that (1) for all $\{\hat{P}, \hat{K}\}$, no firm could earn positive profits offering an additional $\hat{K}$ units of inventory at price $\hat{P}$, and (2) for any pair of prices and inventories $\{\{P_1, K_1\}, \{P_2, K_2\}\}$,

[35] See Deneckere and Peck (1995).

the consumers' allocation rule assigns a fraction θ to $\{P_1, K_1\}$ and $1-\theta$ to $\{P_2, K_2\}$ such that no individual consumer would be better off if he unilaterally switched suppliers.[36] One clear implication is that every firm offering the same price will offer the same equilibrium service rate.

Given this definition, the unique competitive equilibrium is the price and inventory which maximizes consumer surplus (3.6) subject to the downstream firms' zero-profit condition:

$$[(1-r)P - d]\, S(K) - tK = 0, \tag{3.7}$$

where downstream profit is the profit margin on each unit sold, $[(1-r)P - d]$, multiplied by the total expected sales, $S(K)$, less the cost of capacity, tK.[37]

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[36] The fraction θ depends on the prices and quantities but the notation has been suppressed. See Deneckere and Peck (1995) and Carlton (1978).

[37] Let the solution to this program be $\{P', K'\}$ and suppose it is *not* the competitive equilibrium. Then there exists another *market price and inventory*, $\{\hat{P}, \hat{K}\}$, at which consumers would obtain strictly greater surplus, $(V - \hat{P})S(\hat{K}) > (V - \tilde{P})S(\tilde{K})$, and firms would earn strictly greater profits than at $\{\tilde{P}, \tilde{K}\}$. Starting at the competitive equilibrium, $\{\tilde{P}, \tilde{K}\}$, suppose that an "entrant" offers $\{\hat{P}, k\}$, that is, an *additional k* units of inventory at price $\hat{P}$. A sufficient condition for this to be a profitable strategy is that the entrant's allocation of customers, θ, is greater than $k/\hat{K}$. To prove that this is indeed true, all we need to show is that if the entrant's allocation were exactly $k/\hat{K}$, then consumers would get higher surplus from the entrant than from the rest of the market. Under the proposed allocation, $\theta = k/\hat{K}$, a consumer allocated to the entrant gets expected surplus $(V - \hat{P})S(\hat{K})/E(x)$ (that is, the same surplus that would be obtained if the whole market offered $\{\hat{P}, \hat{K}\}$. A consumer allocated to $\{\tilde{P}, \tilde{K}\}$, on the other hand, receives expected surplus

$$(V - \tilde{P})\left\{\frac{\int_0^{\tilde{K}/(1-\theta)} (1-\theta)xf(x)dx + \int_{\tilde{K}/(1-\theta)}^{\infty} \tilde{K}f(x)dx}{(1-\theta)E(x)}\right\},$$

Solving (3.7) for P as a function of K and substituting the expression into (3.6) simplifies the program and, using (3.2), yields the following first-order condition for $\tilde{K}$:

$$\left(V - \frac{d}{1-r}\right)[1 - F(\tilde{K})] - \frac{t}{1-r} = 0, \text{ or} \tag{3.8}$$

$$V\left[1 - F\left(\tilde{K}\right)\right] = (rV + d)\left[1 - F\left(\tilde{K}\right)\right] + t.$$

The equilibrium capacity $\tilde{K}$ may be understood intuitively. Given a contract *{t, r}*, the competitive market will supply a level of capacity where the expected social value of the marginal unit of capacity, $V\left(1 - F\left(\tilde{K}\right)\right)$, is equal to the expected cost to the downstream firms of providing the marginal unit of capacity, $(rV + d)\left(1 - F\left(\tilde{K}\right)\right) + t$. The cost consists of a direct cost t and an indirect cost $rV + d$ if that unit of capacity is actually used. Comparing $\tilde{K}$ from (3.8) to K^* from (3.4) shows that the costs d and t are now "inflated" to reflect the revenue share paid to the upstream monopolist.

This comparison also highlights how valuable revenue sharing can be. If there were no royalty, so $r = 0$, then comparing (3.8) to (3.4) shows that $t = c$ would implement the (privately) optimal capacity choice, K^*. However, this contract leads the downstream firms to price too low and generates no profits for the upstream monopolist. The upstream firm could extract some profits by raising the price of capacity to $t > c$, but

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since now $(1-\theta)x$ consumers instead of x consumers are chasing the $\tilde{K}$ units of capacity. This expression approaches $\left(V - \tilde{P}\right)S\left(\tilde{K}\right) / E(x)$ as k approaches zero (because $\theta = k/\hat{K}$ approaches zero). Finally, using the assumption that $\left(V - \hat{P}\right)S\left(\hat{K}\right) > \left(V - \tilde{P}\right)S\left(\tilde{K}\right)$ establishes that the consumers are strictly better off with $\{\hat{P}, k\}$ than with $\{\tilde{P}, \tilde{K}\}$ under the proposed allocation. Therefore $\theta > k/\hat{K}$ and we are done: $\{\tilde{P}, \tilde{K}\}$ is not a competitive equilibrium.

by comparing (3.8) to (3.4) we see that the competitive downstream firms would distort their capacity choices and hold $\tilde{K} < K^*$.

Instead, the upstream firm should simultaneously lower the transfer price, *t*, below *c* and raise the royalty, *r*, above zero. In this way, the monopolist can maintain the incentives for the competitive downstream market to hold capacity *K**. In the limit, as *t* approaches zero and *r* approaches $(V-d)/V$, the market price converges to *P**, and the upstream firm earns monopoly profits.

Proposition 1: The vertical-integration outcome is implemented with the revenue-sharing contract $\left\{0,\ \frac{V-d}{V}\right\}$.

The optimal contract lets the downstream firm to obtain inventory freely but then extracts all the profits from downstream sales through the royalty, which acts like a 100% profit tax. This result gives the misleading impression that revenue sharing works only because it creates downstream indifference. However we can show that the contract $\left\{\underline{t}, \left(V-d-\frac{\underline{t}}{1-F(K^*)}\right) \Big/ V\right\}$ uniquely implements K^*, and it is clear that as $\underline{t} \to 0$ this contract approaches the contract characterized in Proposition 1.

Revenue Sharing versus Linear Pricing

Comparing revenue sharing to the (optimal) second best linear contract generates some interesting predictions. First, as noted earlier, any contract with *r = 0* and *t > c* will implement too little capacity: $\tilde{K} < K^*$. Therefore revenue sharing increases the level of

downstream inventories. Second, we will argue that revenue sharing (weakly) raises the wholesale price. These predictions are consistent with the broader trend in the video rental industry and with Blockbuster Video's pricing practices in particular.

To see why revenue sharing (weakly) raises the retail price, suppose that revenue sharing (and other vertical restraints) were not feasible, so the upstream firm could choose only the transfer price *t*. When *r* is zero, the capacity chosen by the competitive downstream firms satisfies $(V-d)[1-F(K)]-t=0$ from equation (3.8). The upstream firm simply chooses *t* to maximize upstream profits, $(t-c)K$, subject to this market equilibrium condition.

If the upstream firm chooses a wholesale price $t<V-d$ then it is easy to show that $P<V$. To see why, suppose instead that $P=V$. So consumers earn zero surplus in equilibrium. However, inspection of equation (3.6) shows that a downstream firm could deviate and lower its price slightly. It would still earn positive margins on each unit since $P>d$, and customers would be guaranteed positive expected surplus and would flock to his store. If, on the other hand, the upstream firm chooses a wholesale price $t=V-d$, then equation (3.8) implies that $K=\underline{x}$; the firms do not hold any speculative inventory and so $S(K)=K$. It follows from the zero-profit condition in equation (3.7) that $P=V$.

The best choice of wholesale price, $t<V-d$ or $t=V-d$, depends upon the distribution of demand, $F(x)$. If, for example, $\underline{x}=0$, then $t=V-d$ is never optimal because $K=\underline{x}=0$ would yield zero profits. More generally, while $t=V-d$ is mathematically feasible, it clearly doesn't describe video retailers inventory decisions – in practice, video retailers do hold speculative inventory. In sum, as long as there is enough demand uncertainty, *t* will be chosen so that $t<V-d$ and so $P<V$. We

conclude that moving from simple wholesale prices (the second best) to revenue sharing (the first best) raises the equilibrium retail prices.

Discussion of the Video Rental Industry

This model is clearly an overly simplistic representation of the video rental industry. Several discrepancies in the assumptions and in the model's predictions stand out. So it is important that we discuss how our results might change as we make our assumptions more realistic.

First, we have assumed that there is a single upstream firm. While the assumption is clearly unrealistic for the movie industry, it is not crucial for the results. Since each film is a highly differentiated product, we can think of our model as solving for the optimal contract for one movie studio, taking as given the contracts it believes other movie studios are writing. In other words, it can be thought of as a model of monopolistic competition. The fact that the retailer carries multiple movie studios' products does introduce strategic issues, however. For example, retailers know that to survive they must carry all the studios' titles. "Common agency" extensions along these lines are beyond the scope of this paper.

Second, the model assumed the upstream firm sells a single product. Clearly each studio sells multiple products and each retailer carries many studios' products. So, in practice, it is not the case that a stock-out results in no revenue; some consumers may simply rent a different title instead. Under revenue sharing that revenue may go to a different studio than the one that would have captured the revenue if there had been no stock-out. This is important because it suggests another reason revenue sharing is attractive to movie studios. Paramount knows that part of the value generated by a hit

title like "Titanic" is that it brings consumers into the store. Yet many of those consumers rent competitors' products if Titanic is not in stock. With revenue sharing, customers will rent a Paramount title – namely "Titanic."

Third, the assumption that the downstream market is perfectly competitive is clearly unrealistic. While some retailers face head-to-head competition in a particular area, others are geographically differentiated and have some power to set local market prices. Indeed, some retailers like Blockbuster have sufficiently many outlets to influence even the average retail price.[38] If our model were extended to imperfect competition with 2 or more downstream firms, the first best would be implemented with a contract that includes lump-sum transfers in addition to revenue sharing.[39] If there were a single monopolist downstream then revenue sharing may be unnecessary: the downstream firm could simply "buy" the upstream firm with a large lump-sum transfer. If lump-sum transfers were not feasible, however, then we would expect revenue sharing to be used along with the transfer price. [40]

Fourth, we assumed there was only one period of demand. The analysis would be unchanged if the good was a durable and was rented for several rental periods, so long as the demand for each rental period were identically and independently distributed. Of course, equation (3.8) would have a different interpretation: it would trade off the present

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[38] 80% of Blockbuster Video outlets are company owned, while 20% are franchised. So Blockbuster controls the retail price directly. Blockbuster Video and Hollywood Video may also have some bargaining power vis-a-vis the movie studio. In theory, this could change the lump-sum transfer but would not affect the revenue share, which is set to maximize the total value in the vertical chain.

[39] For small *n*, the downstream market may not have an equilibrium (see Deneckere and Peck, 1995) so this statement is conditional on *n* being sufficiently large.

value of the stream of rental income against the cost of a single unit of the durable. More generally, if demand were characterized by a sequence of potential correlated (and non-identically distributed) random variables $x_1, x_2, \ldots, x_n$, then Proposition 1 would still hold as long as retailers had to choose a single price and inventory level. If the firms were free to choose a different price before each period, however, revenue sharing might still be attractive but would not generate the vertical integration outcome.[41]

Fifth, our model predicts that the optimal transfer price is zero, even though in 1998 videos were commonly transferred at prices $0 to $6 (this price appears to have declined over time, but is still generally positive).[42] In a sense this is very easy to explain, although at the expense of creating a deeper question. Because video outlets have significant fixed costs and have local market power they would earn positive quasi rents in equilibrium if the wholesale price of a video were zero. Positive quasi rents would lead retailers to stock arbitrarily high inventory levels – a wasteful business practice. A generalization of our model that considered scale economies, imperfect downstream competition, and limits on lump sum transfers would yield positive wholesale prices.[43]

Finally, an interesting feature of revenue sharing contracts that is not predicted by the model in this section is the use of both a royalty and a unit tax on rentals (recall from Section 2 that Twentieth Century Fox charges retailers the greater of 45% and $1.20 per

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[40] Without revenue sharing, there would be a double marginalization problem and the downstream retailer would hold too little inventory. Introducing revenue sharing would help, although the first-best would not in general be obtained.

[41] However revenue sharing will work when there is no uncertainty within each period. This is the model considered in the next section of the paper.

[42] See Rentrak's current contracts at http://www.newppt.com/ in September 2000.

rental transaction). One obvious explanation for this behavior is to limit mid-week discounting. As noted earlier, the model in this section did not allow for separately priced peak and off-peak periods. These demand fluctuations are considered in the next section in a model where prices clear the market, so there are never stockouts or overstocks.

4. Destructive Competition with Declining Demand and Flexible Prices

In the previous section we assumed that the downstream firms set only one price, even though a video is a durable good and there are many periods in which it is rented. Instead, we know that video retailers set different prices for "new releases" and "library" titles and sometimes offer mid-week and volume discounts. In this section we instead consider a model in which the downstream firms are free to adjust their prices in response to changes in demand (and consumers are free to buy from the lowest priced firm). In a competitive market, this implies that the downstream price clears the market and that consumers never face stock-outs and no longer care about availability. This model captures an important element missing in the previous model. Retailers who have the optimal inventory for peak demand periods might be tempted to price inefficiently low in subsequent low demand periods. Even if the upstream market is a monopoly market, system profits could be increased by supporting prices after the 90 day new release period.

The upstream monopolist offers a contract $\{t, r\}$ to the downstream firms, where t is the transfer price per unit of capacity and r is the royalty rate on revenue. Then the downstream firms make their capacity decisions. Unlike the previous model, retail prices

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[43] The model in Section 4 predicts positive wholesale prices in a model with downstream

are free to adjust to market conditions. Retail capacity is not adjustable, however, and is chosen at the beginning of time. Time is continuous and is indexed by $s \in [0,\infty)$, and all agents use a common discount rate, $\rho > 0$. Demand is known but is falling over time. For simplicity we assume that the inverse demand function at time *s* is given by $P = 1 - Q / x(s)$, where $x(0) = \bar{x} > 0$, $x'(s) < 0$, and *x(s)* approaches zero in the limit; this simple form of the demand function implies that, without a capacity constraint, the optimal price of monopolist is independent of *s*. We can interpret this as the demand for a service from a declining mass of homogeneous customers, *x(s)*, each with downward sloping demand, $Q = 1 - P$.[44] The upstream cost of the good is $c > 0$ per unit, and each unit of capacity allows the downstream firms to rent one unit of a final good at incremental cost $d > 0$ per unit time. We also assume $d < 1$.

As a benchmark, suppose that the industry is vertically integrated. First, given capacity, *K*, what is the integrated firm's optimal price and output at each time *s*? In later periods, the capacity constraint is non-binding and the firm simply sets the marginal revenue of a rental, $1 - 2Q / x(s)$, equal to the incremental cost of a rental, *d*. The quantity sold during these later periods is $x(s)(1-d)/2$. During early periods, however, the capacity constraint will bind.[45] The cutoff between these two regimes, $\tau(K)$, is implicitly defined by

$$x[\tau(K)](1-d)/2 = K. \qquad (4.1)$$

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competition and flexible prices.

[44] Consumers might vary in the number of periods that they consume the good before they grow tired of it, or *x* might be derived from some random selection process without replacement on the entire population. These assumptions imply that consumers do not shift their demand to future periods and so the durable goods monopoly problem is avoided.

In the early periods, price clears the existing capacity, $P(s) = 1 - K/x(s)$, while in the latter phase the firm has unutilized capacity and sets price

$$P(s) = (1+d)/2. \tag{4.2}$$

We can now characterize the vertically-integrated firm's optimal choice of capacity. The firm's profits are

$$\int_0^{\tau(K)} K\left[1-(K/x(s))-d\right]e^{-\rho s}ds + \int_{\tau(K)}^{\infty} \frac{x(s)(1-d)^2}{4} e^{-\rho s}ds - cK,$$

and differentiating this expression with respect to K yields the solution, K^*:

$$\int_0^{\tau(K^*)} [1-2K^*/x(s)-d]e^{-\rho s}ds - c = 0. \tag{4.3}$$

At time s in the early phase, the marginal return associated with an additional unit of capacity is $[1-2K^*/x(s)-d]$, the marginal revenue of a rental minus the incremental cost of a rental. The marginal return on an additional unit of capacity in the latter phase is zero because it is never utilized. The vertically-integrated firm expands capacity to the point where the discounted marginal return on capacity equals the marginal cost, c.

The salient point is that a vertically-integrated firm intentionally under-utilizes its available capacity and limits price reductions during low-demand times.[46] When the industry is vertically separated with competition downstream, there will be a tendency for the downstream firms to engage is "destructive competition," over-utilizing their existing capacity and competing fiercely in price. Absent vertical restraints, the upstream firm will sell less capacity to retailers to prevent subsequent price collapses in low demand periods.

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[45] More precisely, it will bind so long as $K < \bar{x}(1-d)/2$.

[46] This result holds when the demand variation over time is sufficiently large and a vertically integrated firm's optimal *ex post* rentals are not always equal to its capacity or inventory, which is implied by our assumption that *x(s)* approaches zero.

The upstream firm wants to adopt vertical restraints in order to (1) prevent fire sales during these low-demand times, while (2) still encouraging the downstream firms to hold adequate inventory.

Now suppose that the industry is vertically separated with contracts *{t, r}*. What is the competitive outcome when the total industry capacity is K? In later periods not all capacity is used and the market price is driven down to the point where the downstream marginal revenue (after paying the royalty) is equal to the incremental cost of a sale,

$$(1-r)P(s) = d\,. \tag{4.4}$$

The quantity demanded during this phase is $x(s)\left(\frac{1-r-d}{1-r}\right)$. In early periods, however, all capacity is used and the market-clearing price is $1-K/x(s)$. The cutoff between these two regimes, $\sigma(K)$, is implicitly defined by

$$x(\sigma(K))\left(\frac{1-r-d}{1-r}\right) = K\,. \tag{4.5}$$

We can now characterize the competitive industry's choice of capacity given contract *{t, r}*. In the early phase, the competitive downstream firms earn an *ex post* return or rent of $(1-r)[1-K/x(s)]-d$ on each unit of capacity. In the later periods, not all capacity is used and there are no *ex post* rents. Hence, the industry capacity will expand to the point where the downstream firms' discounted marginal return on a unit of capacity is equal to their marginal cost of capacity:

$$\int_0^{\sigma(\tilde{K})} \{(1-r)[1-(\tilde{K}/x(s))]-d\}e^{-\rho s}ds - t = 0\,. \tag{4.6}$$

To illustrate the value of revenue sharing, imagine that the monopolist sets the unit transfer price equal to marginal cost, $t = c$, and the revenue share equal to zero, $r =$

0.[47] Two distortions would arise. First, comparing (4.2) and (4.4) shows us that during the later periods when demand is low the competitive market will set too low a price (recall that $d < 1$). It is not possible for the competitive market to commit itself not to use all its available capacity *ex post*. A contract with a revenue share or royalty $r^* = \frac{1-d}{1+d}$ solves the *ex post* pricing distortion and commits the competitive downstream market not to use all available capacity. Second, comparing (4.3) and (4.6) establishes that under marginal cost pricing the competitive market would choose a capacity level that is too high.[48] Given r^*, a transfer price $t^* = \left(\frac{d}{1+d}\right)c$ gets the competitive firms to choose K^*.

Proposition 2: If there is perfect competition downstream, the upstream monopolist will implement the vertically integrated outcome with a revenue-sharing contract $\left\{\left(\frac{d}{1+d}\right)c,\ \left(\frac{1-d}{1+d}\right)\right\}$.

Revenue Sharing versus Linear Pricing

Comparing revenue sharing to the (optimal) second best linear contract generates some interesting predictions. First, revenue sharing unambiguously raises prices for the very oldest videos (the "library" titles). Without revenue sharing, the downstream firms sell at cost, $P(s) = d$, in the low demand phase. With revenue sharing, the retail price is

[47] Of course if r were restricted to be zero then the monopolist would optimally set $t > c$. The implications of this are discussed later.

[48] When $r = 0$ and $t = c$, (4.1) and (4.5) imply $\tau(K) = \sigma(2K)$. Therefore comparing (4.3) and (4.6) shows that the competitive market would choose exactly twice the optimal level, $\tilde{K} = 2K^*$.

propped up during these low demand times: $P(s) = (1+d)/2$. Second, we will show that revenue sharing tends to increase downstream capacity when compared with linear pricing. Since the prices clear the market when demand is high, this implies that revenue sharing leads to lower prices for recent releases. In fact, as we indicated earlier, it appears likely that Blockbuster raised the price of new releases following the adoption of revenue sharing in 1998, so in this respect the facts are more consistent with our first model.

To see why downstream capacity rises with revenue sharing, consider the following example $x(s) = \frac{1}{\alpha} e^{-\rho s}$. Demand falls over time and approaches zero in the limit. Using equations (4.1) and (4.3), *K** is defined implicitly by:

$$2\alpha K^* \left\{ 1 + \ln\left[\frac{1-d}{2\alpha K^*} \right] \right\} = 1 - d - \rho c . \qquad (4.7)$$

When constrained to offer contracts with *r = 0,* the monopolist will choose the wholesale price t to maximize upstream profits, $(t-c)K$, subject to the constraint the downstream firms choice of K, determined by equations (4.5) and (4.6), is $\alpha K \left\{ 1 + \ln\left[\frac{1-d}{\alpha K} \right] \right\} = 1 - d - \rho t$. We can solve this constraint for *t* as a function of K and substitute it into the monopolist's program and show that the optimal K is

$$\alpha \tilde{K} \left\{ 1 + 2\ln\left[\frac{1-d}{\alpha \tilde{K}} \right] \right\} = 1 - d - \rho c . \qquad (4.8)$$

It is then straightforward to check that if $\tilde{K} = K^*$ then the left hand side of (4.8) would be larger than the left hand side of (4.7). Since the left hand side of (4.8) is concave and increasing in $\tilde{K}$ for $\tilde{K} \leq K*$, it follows that $\tilde{K} < K^*$.[49]

Discussion of the Video Rental Industry

This model is also an overly simplistic representation of the video rental industry. In particular, this model ignores stock-outs, which we have already argued are an important characteristic of the video rental industry. Nevertheless, the model does capture an important dimension of the industry missing from the other model: increasing inventory during peak demand periods may lead to opportunistic "destructive competition" during off-peak periods. In other words movie studios choose not to increase copy-depth during the first 30 days a movie is released because, by anticipating fire sale prices later, retailers' willingness-to-pay for videos will be diminished. Here, revenue sharing not only stimulates inventory holding in the first 30 days of release, but also prevents excessive price cutting when demand falls.

Of course this model could easily be interpreted as a model of demand uncertainty instead of declining demand. Alternatively, it could be interpreted as a general model of time-varying demand: it is not necessary that the variation in demand be monotonic, only that they be sufficiently large. Thus we could easily adapt the model to consider peak load demand, such as weekend video rentals, without changing the results. In this case *x*

[49] The left hand side of (4.8) is a concave function of $\tilde{K}$ and reaches a maximum at $\overline{K} = (1-d)/(\alpha\sqrt{e})$. Since K^* must be smaller than $(1-d)/2\alpha$ and $(1-d)/2\alpha < \overline{K}$ (since $\sqrt{e} < 2$), it follows that the left hand side of (4.8) is increasing in *K* when $K = K^*$.

would not decline over time, but would fluctuate systematically. [50] We assume demand changes predictably over time because time-varying demand (declining popularity and peak demand on weekends) is an important characteristic of our service and rental industry applications.

5. Comparing Vertical Restraints

This paper argues that royalty payments, or revenue sharing, solve coordination problems generated by vertical separation, demand uncertainty, and downstream competition. Previous work has shown that other vertical restraints, including resale price maintenance and returns policies, accomplish the same coordination. Which contractual arrangement should we expect to see used?

Marvel and Peck (1995), Kandel (1996) and Padmanabhan and P'ng (1997) have examined the role of returns policies (or buybacks) in models similar to the one we presented in Section 4. Each of these papers considers a model of inventory choice, pure resale, and uncertain (as opposed to declining) demand. Returns policies are valuable in these papers precisely because they serve to monitor downstream rentals or sales, and are in this way similar to revenue sharing. (A returns policy would also implement the vertical integration outcome in our first model, although to our knowledge no previous work has shown this).

The choice between a returns policy and a revenue sharing contract is a choice of logistics and monitoring technology, not simply an optimal contract choice. An obvious disadvantage of returns policies is that the physical return of products is costly. Suppose

[50] For revenue sharing to be useful the fluctuations in demand would have to be large enough that profits are not maximized at the market clearing prices but instead when retailers do not use all their capacity at off-peak times.

that instead of revenue sharing, the video retailers buy the videos outright but can always return them at a fixed price. In our first model, retailers would ship returns after a low demand realization. In the second model, retailers would ship returns as popularity declines after a title is sufficiently old. However, in a dynamic extension of model one, or an extension of model two that exhibited weekend peaks (so demand did not decline monotonically), then under the so-called optimal returns policy firms would have to adjust their capacities before every rental period. For example a video retailer may choose to return tapes on Monday when demand is low only to have them shipped back in time for the weekend. The transactions costs associated with these "optimal" buyback schemes would, of course, be prohibitively expensive. While revenue sharing works more efficiently because it tracks each transaction without using the physical shipment of inventories, it requires investment in sophisticated monitoring technologies. The choice between the two systems depends on the relative transactions costs. This suggests that revenue sharing will be adopted by larger retailers who are in a good position to bear these costs, while small retailers may find revenue sharing too expensive.[51]

Another alternative to revenue sharing contracts is resale price maintenance. In a model similar to our second model in Section 4, Deneckere, Marvel and Peck (1997) showed that minimum resale prices (price floors) will prevent *ex post* destructive competition (though with their more general demand system price floors may not implement the vertical integration outcome). Resale price maintenance implements the

[51] As discussed in Section 2, there are alternative copy depth programs where retailers must return their inventory after the new release period is over (90 to 120 days). This story is also consistent with what we observe in book retailing. Publishers economize by allowing retailers to return only the cover of unsold paperbacks. We should infer that in

vertical integration outcome in our first model (although to our knowledge no prior work has shown this). Resale price maintenance, however, may face legal challenges while revenue sharing or royalties are rarely challenged.[52] To avoid charges of resale price maintenance, manufacturers sometimes use "suggested retail prices." This policy would not implement the vertical integration outcome in our declining demand model in Section 4, since the retail price must be free to rise when demand is high.

Quantity forcing and volume discounts are other alternatives to revenue sharing. While video outlets would hold more inventory under these contracts, they have no reason to restrain their price cutting. Since firms' capacity costs are sunk, price is always driven below the vertical integration level. There is no instrument to soften price competition; these contracts cannot adequately control both inventory levels and the retail price. In our second model quantity forcing and volume discounts do not prevent destructive pricing when demand is low. Nevertheless some studios have experimented with volume discount pricing programs, usually in combination with returns policies. While this eliminates the heavy discounting of movies after the new release period is over, it would still result in inefficiently low average prices and excessive discounts for off-peak times.

Another problem with these programs is that they do not allow the outlet the flexibility to take advantage of private information about local demand. However when retailers may have private information about demand, resale price maintenance (if legal)

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the case of book publishing the cost of monitoring sales is larger than the physical cost of returning paperback covers.

[52] Chen (1999) provides a good discussion of the legal status of resale price maintenance.

may be more attractive to the upstream monopolist than a returns policy or revenue sharing (see Butz, 1998).

Also, in differentiated product markets these programs are unlikely to significantly impact the price level unless more than one outlet in a given area both employ volume discounts. Even then it isn't obvious that retailers always price optimally. Nevertheless if a large proportion of video outlets used volume discount supply programs we would predict a significant decline in the price of a rental.

Finally, one may ask why the upstream firm does not contract with a single downstream firm and implement the vertical integration outcome with a two-part tariff. There are reasons why it may not make sense for movie studios to adopt an exclusive relationship (or integrate) with one video retailer. First, given the incomplete nature of contracts, it might be difficult for the upstream firm to commit to deal with just one retailer. After entering into a contract with one retailer the upstream firm would have an incentive to cannibalize that retailer by contracting with a second. See Hart and Tirole (1990), O'Brien and Shaffer (1992), and Alexander and Reiffen (1995). Second, the video retail industry is characterized both by some degree of geographic differentiation and by strong consumer demand for variety and selection (so video retailers distribute the movies of many different studios). By dealing exclusively with one retailer a movie studio may restrict the market for its releases.

5. Concluding Remarks

This paper has considered two models in which an upstream firm wants to encourage inventory holding while softening price competition among its downstream retailers. Without additional restraints, downstream firms will hold to little inventory

because demand is uncertain (or variable) and the need to use the transfer price to soften price competition creates a wedge between the firms' joint incentives to hold inventory and the downstream firms' private incentives to hold inventory. In each of our models we showed that revenue-sharing contracts, together with a linear input price, correct these distortions and implement the vertical-integration outcome.

While the assumptions of these two models differ from each other, we believe that each captures important features of the video rental industry. Combining the two models into one model might help if we were trying to calibrate our model precisely to the video industry example**.** A more realistic model of the video industry would have of both random and systematic elements of demand variation, and would allow downstream firms to vary price in response to the systematic elements. Such a model would make it difficult to discern the different effects described in each model. Also in a hybrid model revenue sharing would be unable to implement the first best outcome so vertical integration would appear to be the more attractive option (but see the discussion above on the problems with vertical integration). Still, it is clear that such an extension would nevertheless predict that revenue sharing is a valuable instrument for encouraging inventory holding and softening downstream competition.

There is little doubt that revenue sharing programs increase copy depth. This is the clearly articulated objective of every firm that uses them. However it is more challenging to find evidence that revenue sharing is also attractive to movie studios because it softens downstream competition. There is no reason for the studios to address this issue in their marketing materials and even less for them to discuss it with the public. However the anecdotal evidence that new release prices are rising relative to others offers

is consistent with revenue sharing softening downstream price competition. Also, the use of a combination of a percentage and a unit price royalty is evidence that studios are worried about supporting prices at off peak times.

The idea that revenue sharing can encourage inventory holding and soften downstream price competition applies to other industries as well, including supply contracts in manufacturing. For example, many of the suppliers of aircraft engine parts, who often have considerable market power, operate under revenue-sharing agreements with engine manufacturers, who compete fiercely for contracts with major carriers.[53] If the downstream demand for manufactured products is variable or stochastic, then it may be efficient for downstream firms to stockpile parts that will be readily available when an order comes in. If the supply contracts simply specified a marked-up linear price for the parts, then too little inventory would be held, delivery of the final products would be delayed, and economic value will be foregone. Revenue sharing, along with a low linear price, can more efficiently align the incentives in the vertical chain.

[53] For example, Lucas Aerospace recently entered into a revenue-sharing contract with Rolls-Royce to supply engine and fuel control systems for the new generation of Trent Engines. "Team on Trent Engines," *Aviation Week and Space Technology,* January 19, 1998. Under the terms of the deal, Lucas will invest $122 million and receive 3-5% of the total revenues from the engines.

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