BUYING, SHARING AND RENTING INFORMATION GOODS*

Hal R. Varian†

Information goods such as books, journals, computer software, music and videos can be copied, shared, resold, or rented. When such opportunities for sharing are present, the content producer will generally sell a smaller amount at a higher price which may increase or decrease profits. I identify three circumstances where profits increase: (1) when the transactions cost of sharing is less than the marginal cost of production; (2) when content is viewed only a few times and transactions costs of sharing are low; and (3) when a sharing market provides a way to segment high-value and low-value users.

I. INTRODUCTION

INFORMATION GOODS, such as books, journals, computer software, and video tapes are often rented or shared, and there are several social institutions such as libraries, video stores, and used book stores that facilitate such sharing. It is sometimes thought that the existence of institutions that facilitate sharing is bad for the original producers of the goods. However, on reflection this is not so obvious. It is true that the presence of a library may reduce the demand for purchases of books, but because there are many readers who benefit from a library's purchase of a book, the price the library is willing to pay will generally exceed the price that individual users would be willing to pay. This tradeoff is the fundamental concern of this paper.

Ordover and Willig [1978] examined the problem of determining the socially optimal price of 'sometimes-shared' goods, such as academic journals. However, we concentrate on the behavior of profit-seeking firms, which lends quite a different flavor to the analysis.

Liebowitz [1985] and Besen and Kirby [1989] examined the economics of copying, which has several features in common with the topic considered here. Another relevant literature is the literature on second-hand markets, such as Swan [1972], Swan [1980] and Liebowitz [1982]. Each of these strands of literature emphasizes the fact that the existence of

technologies for sharing, copying, or reselling a good has the two effects on the profitability of selling originals that I mentioned above: (1) the originals are more valuable to the users since there is more than can be done with them, and (2) the producers may sell fewer originals since there is more competition from copies, second-hand goods, or the rental market.

It is a good idea to have a few specific cases in mind before starting the theoretical analysis.

For-profit circulating libraries. In eighteenth century England bookstores started to rent out books creating several hundred for-profit 'circulating libraries.' Patrons would pay a subscription fee and/or a rental fee for borrowing books. Many such libraries survived well into the twentieth century.

Software sharing. When computer software became a mass-market industry in the 1980s, it was quite common to observe groups of individuals that would purchase software that they would share among themselves. Initially this was done illegally, but later software producers encouraged sharing with site licenses, license servers and similar technology. Recently, Application Service Providers have been experimenting with providing access to enterprise software via the Internet (See, for example, Delaney [1999]).

Video stores. During the 1980s over 28,000 video rental stores were established in the US. The explicit purpose of these stores was to rent videos for home viewing. Movie studies were initially opposed to home video, but later found it to be a very profitable business.

Resale markets. Second-hand markets are a form of sequential sharing, in which the effective rental price is the difference between the new price and the price at which the item can be resold. Textbooks are often bought and sold on such markets.

Interlibrary loan. It is a common practice for a group of academic libraries to share the cost of subscribing to rarely-used journals. The journal issues are then shared among the members of the coalition.

We will return to these examples after considering a few models of renting and sharing. We will generally state the models in the context of a specific example, such as books or videos, but the models themselves are meant to describe a range of sharing phenomena such as rental, resale, copying, and second-hand markets.

II.   THE SIMPLEST MODEL

Consider a model with a fixed number of consumers, each of whom wants to read a specific book. Order the consumers by their willingness to pay to read the book and denote the willingness-to-pay of the yth consumer by $r(y)$. The marginal cost of production of the book is c and the fixed costs

of production are F. The publisher of the book chooses its output to solve the monopoly profit-maximization problem

(1) $$\max_{y} \ r(y)y - cy - F.$$

Denote the solution to this problem by y_b, with the b standing for 'buy'.

Now suppose that the consumers form clubs with k members each.[1] Each member of the club will make an equal contribute to the club, and revenue from these contributions will be used to purchase the book and share it among the members.[2] Hence if the producer prints x copies of the book, it will be read by kx consumers. We suppose that there is some 'transactions cost' to sharing the book comprised of travel to the club's library, waiting one's turn, and so on, which we denote by t.

We also assume that the club formation is *efficient* in the sense that the willingness to pay for the book by all members of clubs that purchase the book exceeds the willingness to pay by members of clubs that do not purchase the book. If this were not the case, one of the members of a club that didn't purchase the book would be willing to switch places with a member of a club that did purchase the book, and pay the appropriate compensation.

Given this assumption, we can derive the inverse demand function by the clubs to purchase the book. Note that the inverse demand function by the clubs measures the willingness to pay by the marginal club. Since we are assuming that all clubs face the same price, and all members contribute the same amount towards purchase, the marginal club will be the club that contains the marginal consumer—the one with the lowest willingness to pay. If kx copies of the book are read, the marginal consumer will value the book at $r(kx)$. We assume he pays a transactions cost of t to read the book in the club, so if kx copies are read, the most that the marginal reader will pay is $r(kx) - t$. Since there are k members in the club and they all pay the same price, that price must be $k[r(kx) - t]$.

For example, suppose that there are 6 consumers with willingnesses to pay given by [9,8,7,6,5,4]. If the price is set at 6, then 4 consumers will buy the product. Suppose now that 3 clubs of two people form, as in [(9,8), (7,6), (5,4)]. If each person contributes the same amount towards the group purchase, and transactions costs are zero, then the producer will sell to one group if it sets a price of 16 ($= 2 \times 8$) and to two groups if it sets a price of 12 ($= 2 \times 6$). If the groups are [(9,6), (8,7), (5,4)] the producer will still sell to one group if it sets a price of 14 ($= 2 \times 7$) and two groups if it sets a price of 12 ($= 2 \times 6$), illustrating that it is the minimum willingness to pay in the marginal club that determines the price.

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[1] Here k is exogenous; we investigate how k might be determined endogenously below.
[2] Bakos *et al.* [1998] examine a model of sharing in which users contribute to the purchase of the shared item according to their willingness-to-pay, which will generally involve unequal contributions. In general such a contribution scheme will not be incentive compatible.

We assume that the producer cannot price discriminate between individuals and clubs. The profit-maximization problem for the producer when clubs form is

$$\max_{x} \; k[r(kx) - t]x - cx - F.$$

We can rewrite this expression as

$$\max_{x} \; r(kx)kx - \left(t + \frac{c}{k}\right)kx - F.$$

Letting $y = kx$, this problem is equivalent to

(2) $$\max_{y} \; r(y)y - \left(t + \frac{c}{k}\right)y - F.$$

Note that this equation is very similar in form to Equation (1), differing only in the form of the marginal cost.

Let y_r be the solution to the rental profit maximization problem described in expression (2). It is easy to see that $y_r > y_b$ if and only if

$$t + \frac{c}{k} < c,$$

which we can write as

(3) $$t < c\left[\frac{k-1}{k}\right].$$

Fact 1. When libraries are available and

$$t < c\left[\frac{k-1}{k}\right]:$$

(1) more books will be read; (2) consumers will pay a lower price per reading; (3) the sellers will make a higher profit; and, (4) consumers will be better off.

The intuition is reasonably straightforward: the monopolist wants to make the total cost of producing a 'read' as cheap as possible. The marginal cost of producing a read in the buy mode is c. The marginal cost of producing a read in the rent mode is $c/k + t$, since a reader pays $1/k$th of the production cost but the entire transactions cost. Renting will be preferable for the producer when $c/k + t < c$, which is the condition given in Fact 1. When the condition holds, sharing is the superior technology for producing 'reads' and everyone benefits by adopting that technology.

An interesting special case is when $t = 0$. The profit-maximization problem can be written as:

$$\max_{y} \ p(y)y - \frac{c}{k}y - F.$$

It is immediate that condition (3) is met and that $y_b > y_r$. Here there are no transactions costs to sharing, but fewer copies are needed, so production costs are lower and social welfare is higher when using the sharing technology.

When $t = c = 0$ we have the purely neutral case: if k readers costlessly share the book, the producer simply multiplies the price by k and perfectly offsets the sharing. Consumer surplus and profits are the same with or without sharing.

One can interpret the transactions cost term in this model more broadly. For example, consider academic journals, which are often kept for reference. In this case the transactions cost variable should include the cost of storage and retrieval. If there are economies of scale in storage and retrieval, libraries would be more cost effective than individuals and t could easily be negative. In this case the sharing model is preferred by both the producers and the consumers.

Liebowitz [1985] argues that the introduction of photocopying in the early 1960s led to significant increases in the price of journals. In our model, the introduction of photocopying reduces the transactions costs of sharing, and raises the price of journals, consistent with Leibowitz's argument.

III.   GROUP WILLINGNESS TO PAY

In the last section we assumed that the group's willingness to pay for the item was k times the willingness to pay of the marginal individual in the group. This seems natural for a rental market, such as video tapes, but one could consider alternative formulations for a sharing model, such as a nonprofit library.

Bakos *et al.* [1998], for example, specify that the demand by the library should be the sum of the willingnesses to pay by the users. This assumes that librarians are somehow able to solve the public goods preference revelation problem.

We can parameterize other models of group willingness to pay by specifying the demand function for the groups as $\ell[p(kx) - t]$. When $\ell = k$, we have the case examined earlier. The profit maximization problem under rental in this specification takes the form

$$\max_{x} \ \ell[r(kx) - t]x - cx,$$

which, using the same manipulations as earlier, can be written as

$$\max_{y} \ \frac{\ell}{k}\left[r(y)y - \left(t - \frac{c}{\ell}\right)y\right].$$

Fact 2. If $\ell > k$ and $t + c/\ell < c$, profits increase under rental/sharing. If the inequalities are reversed, profits decrease.

A particularly interesting case occurs in the case of a pure information good, when $t = c = 0$. In this case, the profit maximization problem reduces to

$$\max_{y} \frac{\ell}{k} r(y)y.$$

It follows that for a purely digital good, with no marginal production costs and no transactions costs for sharing, the amount of the good that is 'consumed' is independent of the sharing arrangement. The impact of sharing on profits depends on how the value of the shared good increases as compared to how the number of copies sold decreases. If the first effect outweighs the second, profits will increase, otherwise they will decrease.

IV.   DIFFERENT VALUES OF BUYING AND RENTING

In the above model it was assumed that the consumers only used the product a single time: renting produced the same utility as owning. Some products, such as children's videos, are viewed multiple times. Presumably the utility from buying such products exceeds the utility from renting them due to the ease of multiple viewings.

Suppose that all consumers have the same preferences. Let u_b be the utility from buying a video, and u_r the utility from a single renting of the video. Let b be the price of buying the video. We suppose that k consumers can share the video and that competition in the video store industry forces the price of rental down to b/k. We assume that there is a transactions cost to renting a video that we denote by t. For simplicity we will set the marginal cost and fixed cost of production to zero for the rest of this paper.

The producer of the video gets to set the price, recognizing that the consumers will respond by either buying or renting. We suppose that the producer cannot price discriminate between these two groups so that there must be only one price for sale of a video, regardless of whether it is viewed by a single consumer or rented to several consumers.

The producer can price the video so that everyone buys it, or so that everyone rents it. We examine each case in turn.

If the producer prices for the buy market, it faces the constraints:

$$u_b - b \geq 0$$

$$u_b - b \geq u_r - \frac{b}{k} - t$$

The first equation is the participation constraint: consumers must get nonnegative value from buying the video. The second equation is the

incentive compatibility constraint which says that the customer must be better off buying than renting. Rearranging these constraints gives us

$$u_b \geq b$$

(4)
$$\frac{k}{k-1}[u_b - u_r + t] \geq b.$$

If the producer prices for the rental market, it faces the constraints:

$$u_r - \frac{b}{k} - t \geq 0$$

$$u_r - \frac{b}{k} - t \geq u_b - b$$

Rearranging these gives us

$$k[u_r - t] \geq b$$

(5)
$$b \geq \frac{k}{k-1}[u_b - u_r + t]$$

Either constraint in (4) may bind. If the first constraint is the binding constraint, then it can be shown that it is more profitable to price to buy rather than to rent. The second constraint is the interesting one.

If the second constraint binds we have:

(6) $\text{profit in buy market} = b_{buy} = \dfrac{k}{k-1}[u_b - u_r + t].$

In the rental market only the first constraint in (5) can bind, which gives us

(7) $\text{profit in rental market} = \dfrac{b_{rent}}{k} = u_r - t.$

The first observation we make is that when the rental market prevails, the producer's profits are *decreasing* in the transactions cost, t, and when the buy market prevails, the producer's profits are *increasing* in the transactions cost. This is because the operative constraint in the buy market is the *possibility* of renting; the less attractive this possibility, the higher the price the producer can charge.

V.   BUY OR RENT?

The producer may want to price the video so that consumers choose to buy it or to rent it. Note that this is a different question than was addressed in Section I. There we asked whether it would be more profitable to *outlaw* a sharing/rental market or to encourage it; the answer depended on the relationship between the marginal cost of production and the transactions cost of sharing. Here we are presuming that the rental market

can exist, and that it constrains the producer's pricing behavior: if it sets too high a price, consumers will choose to rent.

Keeping this in mind, let us seek conditions under which the buy market is the more profitable alternative. This will occur when

(8) $$\frac{k}{k-1}[u_b - u_r + t] > u_r - t.$$

Rearranging this we have

(9) $$u_b > \left(2 - \frac{1}{k}\right)(u_r - t)$$

Fact 3.   For large k, if the value of buying is more than twice the net value of renting, buying is more profitable; otherwise, renting is more profitable.

We can restate this result in a somewhat more intuitive way. Let us suppose that if the video is rented, it will be viewed once, yielding utility $u_r = v$. If it is bought, it will be viewed m times, yielding a utility of $u_b = mv$. In this case, we can rewrite inequality (9) to

(10) $$\left(m - 2 + \frac{1}{k}\right)v \geq -\left(2 - \frac{1}{k}\right)t$$

This will certainly hold if $m \geq 2$. Hence:

Fact 4.   If a movie will be viewed 2 or more times, the producer will find it more profitable to sell it than to rent it.

VI.   DETERMINATION OF THE OPTIMAL GROUP SIZE

In the analysis presented so far k, the number of readers per book or viewers per movie was exogenous. Here we offer a model to determine the equilibrium number of viewers.

Suppose that the library buys one copy of a book.[3] Suppose further that each reader takes the book for 1 week and that k readers share the book. Assume that the book is shared among the readers randomly. With probability $1/k$ the reader gets the book immediately; and with probability $1/k$ he has to wait $1, 2, \ldots, k - 1$ weeks. Hence the expected waiting time is $(k - 1)/2$.

Let $2w$ be the monetary equivalent of the cost of waiting one week.[4] The expected cost of waiting is therefore $w(k - 1)$. The benefit of the club

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[3] The analysis can easily be extended to the case of multiple copies.
[4] The 2 is there to simplify formulas below; it has no intrinsic significance.

is the fact that the price of the book, b, is shared among k members. To find the optimal size club we must solve

$$\min_{k} (k-1)w + \frac{b}{k}$$

The answer to this minimization problem is

$$(11) \qquad k^* = \sqrt{b/w},$$

which has just the comparative statics that one would expect.[5]

This gives us the optimal sized group for a given price of the book; Equation (7) gave us the optimal price for a given size group. Substituting from Equation (11) into (7), the Nash equilibrium if the book is rented is the solution to

$$k^2 = \frac{b}{w}$$
$$b = k[u_r - w(k-1)].$$

The solution is

$$(12) \qquad \begin{aligned} k_{rent} &= \frac{u_r + w}{2w} \\ b_{rent} &= \frac{(u_r + w)^2}{4w} \end{aligned}$$

The profits to the producer are

$$\text{profits} = \frac{b_{rent}}{k_{rent}} = \frac{u_r + w}{2}.$$

Unlike the previous model, profits are now *increasing* in the transactions costs of renting. An increase in w reduces the size of the group and also decreases the willingness to pay for renting the item. Since there are now more smaller groups, the producer sells more videos, albeit at a lower price. In this model, at least, the effect of selling more copies dominates the effect of the lower price and profits increase.

Turning to the buy case, incentive compatibility says that the consumers must prefer the utility they get from buying to the utility they get from sharing with other consumers. If they share optimally, they will set $k = \sqrt{b/w}$, so incentive compatibility reduces to

$$u_b - b \geq u_r - 2\sqrt{bw} + w.$$

[5] Since the objective function is convex, the optimal *integer* k will be one or both of the two integers that surround k^*. This determination of the optimal group size is similar to that given in Besen and Kirby [1989] except our 'waiting time' model yields a coefficient of $(k-1)$ rather than k.

If this constraint does not bind, we must have $b = u_b$, which is the uninteresting solution.

If the constraint does bind we need to solve:

$$u_b - b = u_r - w(k - 1) - \frac{b}{k}$$

$$k^2 = \frac{b}{w}$$

There are two solutions:

$$b = u_b - u_r + w - 2\sqrt{(u_b - u_r)w}$$

$$k = 1 - \frac{\sqrt{(u_b - u_r)w}}{w}$$

and

$$b = u_b - u_r + w + 2\sqrt{(u_b - u_r)w}$$

$$k = 1 + \frac{\sqrt{(u_b - u_r)w}}{w}$$

Note that the first solution involves $k < 1$, which is nonsensical, so the second solution is the economically sensible solution. As before, the price in the buy market is increasing in the transactions cost.

When is the buy equilibrium more profitable than the rental equilibrium? This occurs when

$$(u_b - u_r) + w + 2\sqrt{(u_b - u_r)w} > \frac{u_r + w}{2},$$

or

$$2u_b - 3u_r + w + 4\sqrt{(u_b - u_r)w} > 0.$$

This will surely hold if

$$u_b > \frac{3}{2}u_r.$$

If $u_b = mu_r$, then all we need is that $m > 3/2$. Hence we find a somewhat stronger sufficient condition than previously for the buy market to be the more profitable:

Fact 5. If the viewer will watch the movie more than once, the producer will want to price it to buy rather than to rent.

VII.   SOME EVIDENCE ABOUT MULTIPLE VIEWS

The above models suggest that the critical feature in determining the pricing of videos is how many times the video will be viewed. Videos that

will be seen only once are natural candidates for rental; videos that will be viewed many times will likely be more profitable if they are priced low for purchase.

Alsop [1988a,b] describes the early history of video sales. According to Robert Klingensmith, president of Paramount's video division and a source in these articles, 'You have to look at more than box office performance to figure out which videos consumers will want to own. It should be highly repeatable family fare that has comedy, music or action-adventure'.

Children are, of course, noted for viewing the same thing repeatedly, and, not surprisingly, the largest class of videos priced for purchase are children's videos. In 1991 children's videos account for at least half the best sellers and 37% of the total sales (Blumenthal [1991]).

VIII.   HETEROGENEOUS TASTES

In the previous analysis, everyone had the same tastes so that either everyone bought the video or everyone rented the video. The interest of the model arises from the tradeoff between two effects of sharing: the fact that the group's willingness to pay is larger than the individual's willingness to pay versus the fact that the sales to the groups will be smaller than the sales to individuals due to the transactions cost.

If tastes are heterogeneous, a new effect arises: the fact that different groups can choose different forms in which to consume the good; i.e., high willingness-to-pay people can choose to purchase a video, while low willingness-to-pay people can choose to rent. This allows the provider to price discriminate between the two groups.

In order to examine this phenomenon, let us suppose that there are two groups, with values of viewing of v_H and v_L, with $v_H > v_L$. We assume that the value from owning is mv_H and mv_L respectively and that the transactions costs of sharing are t_H and t_L with $t_H > t_L$. We suppose that there are H high-value types and L low-value types. A number of pricing strategies are possible.

- *Sell only to the high-value type*
    In this case the price is $b = mv_H$ and profits are $mv_H H$.

- *Sell to both types*
    The price is $b = mv_L$ and profits are $mv_L[H + L]$.

- *Rent to both types*
    Since we must have

$$v_L - \frac{b}{k} - t_L = 0,$$

we have

$$b = k(v_L - t_L)$$

and profits equal to

$$b\left[\frac{H}{k} + \frac{L}{k}\right] = [v_L - t_L][H + L].$$

Comparing this expression to preceding case of renting to both types we see that selling to both is more profitable when $m > 1$ and $t_L > 0$. That is, *as long as there is extra value to owning and the transactions costs of sharing are positive, selling to both groups dominates renting to both groups.*

When $t_L = 0$ and $m = 1$ it is equally profitable to sell and to rent; this is the outcome we saw in the first model we examined.

- Sell to the high-value consumer, rent to the low-value consumer

This is by far the most interesting case; it requires an extended analysis. There are four self-selection constraints on the price:

(13) $mv_H - b \geq 0$ high value type is willing to buy

(14) $mv_H - b \geq v_H - \dfrac{b}{k} - t_H$ high value type prefers buying to renting

(15) $v_L - \dfrac{b}{k} - t_L \geq 0$ low value type is willing to rent

(16) $v_L - \dfrac{b}{k} - t_L \geq mv_L - b$ low value type prefers renting to buying

Combining (14) and (16) we have

[17] $\left(\dfrac{k}{k-1}\right)[(m-1)v_H + t_H] \geq b \geq \left(\dfrac{k}{k-1}\right)[(m-1)v_L + t_L]$

Since $v_H > v_L$ and $t_H > t_L$, there will always exist a price b that induces self-selection.

The seller wants to set the price b as large as possible. Combining Equations (17) and (13) we find that the profit-maximizing price must satisfy:

$$b = \min\left\{mv_H, \left(\frac{k}{k-1}\right)[(m-1)v_H + t_H]\right\}$$

This equation is somewhat easier to understand if we look at the large-k case. In this situation $k/(k-1)$ is about 1 and the formula for b reduces to

$$b \approx mv_H + \min\{0, t_H - v_H\}$$

There are two cases of interest, depending on which component of the second expression is relevant.

Case 1. $t_H > v_H$ (the transactions cost of sharing by the high-value consumers exceeds their willingness to pay.)

In this case the price will be set at the reservation price of the high-value consumers, $b \approx mv_H$. The low-value consumers will then rent; this of course requires that Equation (15) be satisfied at $b = mv_H$, which says

$$v_L - \frac{mv_H}{k} - t_L \geq 0.$$

In this case the presence of the rental market has allowed the producer to price discriminate and unambiguously increases his profits: he sells the same amount at the same price to the high-value consumers and also gets some additional revenue from selling to the rental stores patronized by the low-value consumers.

Case 2. $t_H < v_H$ (the transactions cost of sharing by the high-value consumers is less than their willingness to pay.)

In this case b is approximately $(m-1)v_H + t_H$. Here the producer has to reduce his price below the willingness-to-pay of the high-value consumers in order to get them to buy rather than rent. The profits to the producer in this case are

$$bH + \frac{b}{k}L = [(m-1)v_H + t_H]\left[H + \frac{L}{k}\right]$$

When will these exceed the profits from selling only to the high-value consumers, $mv_H H$? Some algebra shows that this will be the case when

$$[t_H - v_H]H + [(m-1)v_H + t_H]\frac{L}{k} > 0.$$

Since the first term is negative in the case we are examining, the magnitude of the second term is the key issue. Clearly if number of copies sold to the rental market, L/k, is large enough, profits will increase when the rental/sharing market is present.

IX.   IMPLICATIONS OF THE ANALYSIS

I have argued that markets for sharing can easily lead to increased profits for the producer. There are three ways that this can happen.

The first is when the transactions cost of sharing is cheaper than the marginal cost of production. An example of this is the market for rental cars. It is certainly much cheaper to rent a car for a short period than to produce a new car, and it therefore almost certainly the case that the presence of a rental market for automobiles increases the profits of automobile producers.

The second is when the user only wants to view the item once so that the utility of ownership is not much larger than the net utility of sharing. In this case, the firm would like to sell the product at a high price, but the possibility of renting caps the sales price at a low enough point that renting turns out to be preferred to sales.

The third path by which the presence of a rental market can increase profits is when there are heterogeneous tastes. In this case the 'rich' consumers buy and the 'poor' consumers rent. This allows the producer to serve a market that would otherwise go unserved. Examples of this would be the for-profit lending libraries in eighteenth century England. Prior to the formation of these libraries, only the wealthy purchased books. After the circulating libraries were formed, middle class consumers could afford to read book via the lending libraries, which dramatically increased the demand for books.

Video stores had a similar history. In the late seventies, video machines cost over a thousand dollars and pre-recorded tapes sold for nearly one hundred dollars. These were only affordable by the wealthy. The spread of video stores allowed the middle class to avail themselves of this form of entertainment, vastly increasing the size of the market. Currently about 85% of American households own video machines which has allowed for the re-emergence of the for-sale video market on a significantly larger scale. It seems clear that the rental market for videos contributed significantly to the profitability of the film production industry. See Varian and Roehl [1996] for a detailed comparison of the many similarities between circulating libraries and video rental stores.

There are also several interesting implications for current policies and practices. Consider, for example, interlibrary lending. Each library has an incentive to engage in this activity in order to save money on their collection budget. But if enough libraries form 'clubs' to exchange materials, profit-maximizing publishers will simply increase the price of their products. This is particularly easy when the materials in question are only sold to a limited number of academic libraries.

Multinational firms have implemented a sort of 'interlibrary lending' for software licenses, transferring licenses between branches in different time zones (see Salamone [1995]). In our notation, this is an increase in the number of sharers, k. Although this can result in considerable savings by the corporation, the producers will likely respond by increasing the price of the software license.

Recently there has been a great deal of interest in Internet-based Application Service Providers (ASPs), which rent various software services to clients (see Delaney [1999]). The attraction to the clients is that they avoid the cost of installing, maintaining, upgrading, and supporting the software resource, making the transactions cost of sharing very low indeed, perhaps even negative.

X.   NEW BUSINESS MODELS FOR SHARING

In our analysis the video rental stores or libraries have had an arms length relationship with the content providers: they purchased the item on the open market and then rented or shared it. However, one could examine more complex contracts.

Content owners currently sell videos targeted for rental to stores for $60–$100. This is much higher than the marginal cost of production and stores therefore economize on their purchase, leading to inefficient queuing on the part of consumers. Recently video distributors have experimented with different pricing models. In one variation, the video store initially pays the distributor a one-time fee of $2–$4 per videotape and subsequently pays it 40% of rental revenues. This earns the store a profit per rental of about $2.25 (figures taken from Said [1999]). With this sort of revenue-sharing arrangement, stores no longer have strong incentives to economize in video purchases, reducing the queuing for customers. It is this pricing arrangement that has led some video stores to offer 'guaranteed in stock' promotions. Dana and Spier [2000] model this type of revenue-sharing contract.

It is interesting to note that without the inexpensive monitoring of rental revenues provided by smart cash registers, it would be difficult to enforce these revenue-sharing contracts. As a greater number of economic activities become mediated by computers, sophisticated monitoring of transactions will become feasible, allowing for more efficient contractual arrangements in rental markets.

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