Buying/Sharing/Renting Info Goods

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Information goods (books, videos, journals) are sometimes bought and sometimes shared, rented, or loaned.

Examples

- English circulating libraries (1800s).
- Video stores (1980s).
- License servers (1990s).
- Interlibrary loan.
- Rights management systems (200x)

1. Model 1: simple case

$r(y)$ = willingness to pay of individual y to read/view book/video

$cy + F$ = cost of producing y books

For sale only

Profit maximization problem

$$\max_y \; r(y)y - cy - F$$

has solution y^*

Sharing

Form club with k members. Transactions cost of sharing is t. Number of books produced is x, number read is kx.

Assumption 1. Equal payments: so the wtp of club is k times wtp of member with lowest wtp. (Video rental.)

Compare Leibowitz (1985), Besen (1986), Bakos-Brynjolfsson-Lichtman (1998) who use sum of wtps.

Assumption 2. Efficient club formation: the wtp of people in clubs that consume the good exceeds the wtp of people in clubs that don't purchase the good.

Numerical example with individual purchase

6 consumers with wtp [9,8,7,6,5,4], $p = 6$ implies 4 consumers buy.

Numerical example with group purchase

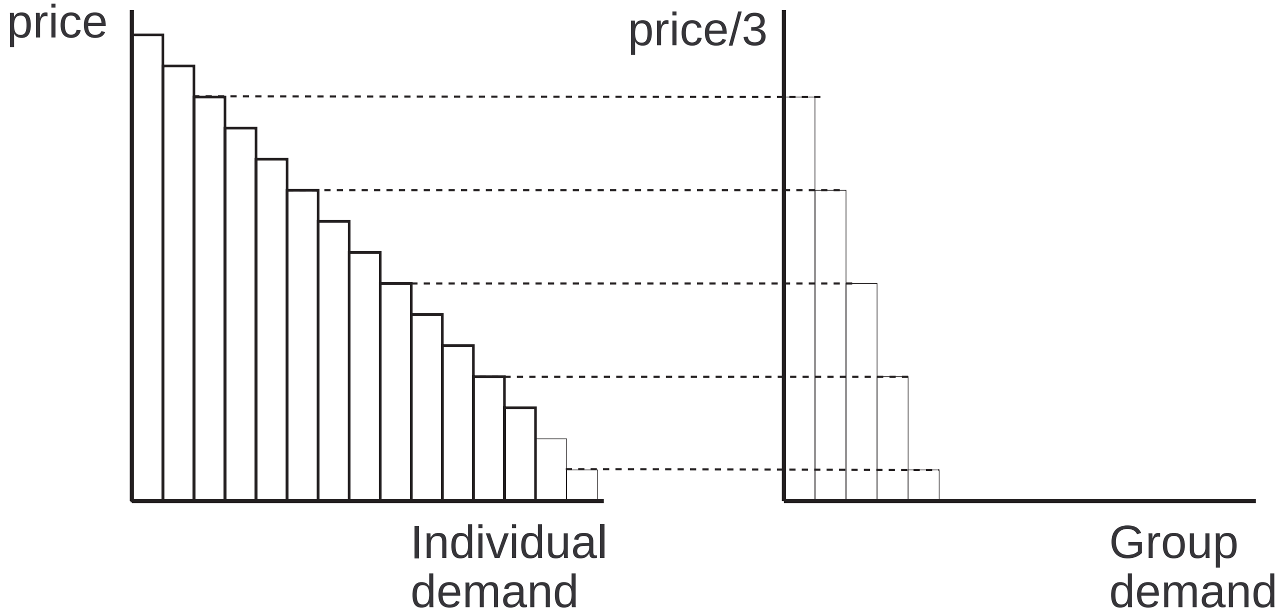
3 groups form: [(9,8), (7,6), (5,4)], leading to wtp of [16,12,8]

$p = 12$ implies 2 groups (= 4 consumers) buy.

Another group formation: [(9,6), (8,7), (5,4)], leading to wtp of [12,14,8]

$p = 12$ implies 2 groups (= 4 consumers) buy.

Demand curve



Analysis

Implies willingness to pay of club to *buy* book is

$$b(x) = kr(kx).$$

If transactions cost to sharing, then

$$b(x) = k[r(kx) - t].$$

Profit maximization problem

$$\max_x \; b(x)x - cx - F$$

Becomes:

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

Letting $y = kx$, we have

$$\max_y \; r(y)y - \left(t + \frac{c}{k}\right) y - F. \tag{1}$$

Let y' be solution to this problem.

Then $y' > y^*$ iff

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

which can be written as

$$t < c\left[\frac{k-1}{k}\right]. \tag{2}$$

Special Cases

k large: reduces to $t < c$.

In this case sharing results in more books being read, lower price per reading, higher profits to producer. Why? Sharing is a more efficient form of distribution.

$t = c = 0$: neutral. Same books read, same profit.

$t \gg c$: more books read without library than with it.

2. Generalization for purely digital goods

Baseline problem is

$$\max_{y} \; p(y)y.$$

Now let $y =$ amount consumed, $x =$ amount produced, and suppose value increases by more or less than k due to free rider problems, overestimation, etc. Specifically:

$$P(y) = ap(y)$$
$$y = bx.$$

Profit maximization for purely digital good:

$$\max_x P(y)x.$$

Becomes

$$\max_y ap(y)x,$$

or

$$\max_y \frac{a}{b}p(y)y.$$

Note: amount of digital good viewed is independent of the sharing arrangement. Profits go up or down depending whether a is larger or smaller than b. Intuition.

3. Model 2: different values

In previous model buying has same utility as renting. What if they are different? E.g., multiple views.

$$\begin{aligned} u_b &= \text{utility from buying video} \\ u_r &= \text{utility from renting video} \\ b &= \text{price to buy video} \\ b/k &= \text{price to rent video (once)} \\ t &= \text{transactions cost to renting} \end{aligned}$$

Incentive compatibility constraint: if b is too large consumers will share

Producer prices to buy

Incentive compatibility

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

Rearrange:

$$u_b \geq b$$
$$\frac{k}{k-1}[u_b - u_r + t] \geq b. \tag{3}$$

Interesting case is where second constraint binds.

Producer prices to rent

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

Rearranging these gives us

$$\begin{aligned} k[u_r - t] &\geq b \\ b &\geq \frac{k}{k-1}[u_b - u_r + t] \end{aligned} \tag{4}$$

$$\text{profit in buy market} = \frac{k}{k-1}[u_b - u_r + t]$$
$$\text{profit in rental market} = u_r - t.$$

Note: in rental market profits are decreasing in t; in buy market profits are increasing in t.

When is buy market more profitable?

$$\frac{k}{k-1}[u_b - u_r + t] > u_r - t,$$

or

$$u_b > \left(2 - \frac{1}{k}\right)(u_r - t) \tag{5}$$

Assume that $u_r = v$, $u_b = mv$. Then equation (5) becomes

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

Conclusion: *if consumers will watch the 2 movie or more times, the buy market is more profitable.*

4. Endogenous group size

Suppose that $t = w(k-1)$. (Due to e.g., simple waiting model.)

Optimal club size:

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

Implies

$$k^* = \sqrt{b/w},$$

Obvious comparative statics.

Nash equilibrium in rental market

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

Solution is

$$k_{rent} = \frac{u_r + w}{2w}$$
$$b_{rent} = \frac{(u_r + w)^2}{4w} \tag{6}$$

The profits to the producer are

$$\text{profits in rental case} = \frac{u_r + w}{2}.$$

Note: now profits are increasing in w!

Two effects of increase in w on profits: reduction in size of group and decrease in wtp.

Nash equilibrium in buy market

Want to raise price as high as possible without inducing (optimal) sharing. Solve:

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

Economically appropriate solution:

$$b = u_b - u_r + w + 2\sqrt{(u_b - u_r)w}$$
$$k = 1 + \frac{\sqrt{(u_b - u_r)w}}{w}$$

When is buy market more profitable?

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

Reduces to:

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

Surely holds when

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

If $u_b = mv$, $u_r = v$, then all we need is that *if viewers watch the movie more than once, the buy market is more profitable.*

5. Heterogeneous tastes

Two groups, with values v_H and v_L for renting, mv_H and mv_L for owning, and transactions costs t_H and t_L with $t_H > t_L$. There are H high-value people and L low-value people and zero cost of production.

- sell only to high-value type: profit $= mv_H H$

- rent to both types: profit $=$ $[v_L - t_L][H + L]$

- sell to both types: profit $= mv_L[H + L]$ (more profitable than renting)

- sell to high-value, rent to low-value

Incentive compatibility:

$$mv_H - b \geq 0 \tag{7}$$

$$mv_H - b \geq v_H - \frac{b}{k} - t_H \tag{8}$$

$$v_L - \frac{b}{k} - t_L \geq 0 \tag{9}$$

$$v_L - \frac{b}{k} - t_L \geq mv_L - b \tag{10}$$

Combining (8) and (10)

$$\left(\frac{k}{k-1}\right)[(m-1)v_H + t_H] \geq b \geq \left(\frac{k}{k-1}\right)[(m-1)v_L + t_L] \tag{11}$$

Can always be satisfied.

Combining (11) and (7),

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

Make approximation that k is large; equation becomes

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

Case 1. $t_H > v_H$

$b^* \approx mv_H$: high-value buys at WTP

$v_L - mv_H/k - t_L \geq 0$: low-value rents

Case 2. $t_H < v_H$

$b^* \approx (m-1)v_H + t_H$

Profits to selling and renting exceed profits from selling only when L/k large:

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

6. Implications

Markets for sharing can increase profits when

- transactions cost of sharing is less than cost of production;
- when users want to use product only once;
- when can be used for quality differentiation to segment market;