Durable goods monopolist

- Coase conjecture: A monopolist selling durable good has no monopoly power.
- Reason:



► Although Q₁ is optimal output of the monopolist, it faces a residual demand of BC in the future. At that time the optimal quantity is Q₂ - Q₁ and price is lower, and so on. If this is true, then consumers (fore-seeing this) will wait for the future low price (P₂), rather than buy it at P₁. If the period of waiting is short enough, then monopolist will be reduced to a competitive firm.

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- Bulow: There are many ways out for the monopolist.
 E.g.
 - 1. Rent rather than sell the good. ('82)
 - 2. Planned obsolescence ('86)
 - 3. Price guarantee
 - 4. Service contract
 - 5. Implicit contract (reputation)

The logic behind Coase conjecture:

Price has to be reduced in order that more goods be sold to residual consumers. Moreover, since the monopolist does not have to bear the cost of lower price for items already sold, he has incentives to reduce price and makes additional profit every time after goods are sold.

In a word, the monopolist faces a commitment problem in that he can't ex ante convice consumers that he won't reduce price ex post.

- One way to make commitment is to rent, rather than sell, his product.
- Intuition: If he rents his product, he suffers from lower rent if he reduces price. The consumers thus believes that price will not reduce later, and are thus willing to pay for higher rent today.

Model

- 2 periods, one monopolist
- Cost of production: 0
- Interest rate: ρ
- Demand for service: $p = \alpha \beta Q$.
- *q_{iC}*: quantity produced by the competitive industry at period *i*.
 (i=1, 2)
- q_{iR} : quantity produced by monopolist renter at period *i*.
- q_{iS} : quantity produced by monopolist seller at period *i*.
- Competitive case: $q_{1C} = \alpha/\beta$; $q_{2C} = 0$

profit =0, price=MC=0

Monopolist renter:

$$\max_{q_{1R},q_{2R}}q_{1R}(\alpha-\beta_{1R})+\frac{(q_{1R}+q_{2R})[\alpha-\beta(q_{1R}+q_{2R})]}{1+\rho}.$$

Solution: $q_{1R} = \frac{\alpha}{2\beta}$, $q_{2R} = 0$.

Rental price= $\frac{\alpha}{2}$; profit in each period: $\frac{\alpha^2}{4\beta}$.

This is exactly what a monopolist with power of commitment will do.

Monopolist seller:

Suppose a quantity of q_{1s} was sold in period 1, then the effective demand in period 2 is

$$\alpha - \beta (q_{1s} - q_{2s}).$$

To maximize period 2 profit, the monopolist sets q_{2s} = α-βq_{1s}/2β.
 Anticipating this, in period 1 the consumer is only to demand the commodity with price

$$p_{1} = \alpha - \beta q_{1s} + (1 + \rho)^{-1} p_{2}$$

= $\alpha - \beta q_{1s} + (1 + \rho)^{-1} [\alpha - \beta (q_{1s} + q_{2s})]$
= $\alpha - \beta q_{1s} + (1 + \rho)^{-1} \left[\alpha - \beta \left(q_{1s} + \frac{\alpha - \beta q_{1s}}{2\beta} \right) \right]$
= $\alpha - \beta q_{1s} + (1 + \rho)^{-1} [\alpha - \beta q_{1s}]/2.$

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The problem of the monopolist:

$$\max_{q_{1s},q_{2s}} q_{1s} p_1(q_{1s}) + (1+\rho)^{-1} (\alpha - \beta q_{1s} - \beta q_{2s}) q_{2s}$$

$$\Rightarrow q_{1s} = \frac{\frac{\alpha}{\beta}}{2 + \frac{1}{2 + (1 + \rho)}} q_{2s} = \frac{\alpha}{2\beta} \left\{ \frac{1 + \frac{1}{2 + (1 + \rho)}}{2 + \frac{1}{2 + (1 + \rho)}} \right\}.$$

 $q_{1s} < q_{1R}, q_{2s} > q_{2R} = 0.$

 $q_{1s} + q_{2s} > q_{1R} + q_{2R}$.

The profit of monopolist is strictly lower in the case when it sells.

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- Some implications:
 - 1. The firm might deliberately develop a technology that has \underline{high} MC, in order to insure low future output, and thus high profit.
 - E.g. investment with fixed and marginal cost.
 - 2. The monopolist might produce good in a way that has lower durability than the optimal: planned obsolescence.

- If not threatened by entry, a monopolist will produce good with inefficiently short life.
- An oligopolist, however, has a countervailing incentive to extend durability, because this gives an advantage over competitors. Thus an oligopolist might choose uneconomically short or long life.

- One monopolist, 2 periods.
- The monopolist chooses quantity q_1 and durability δ in the 1st period. In the 2nd period, δq_1 of the 1st period output survives, and the firm produces an additional q_2 units. The implicit rental price in period 1 is $f_1(q_1)$ and that for 2nd period is $(1 + r)f_2(\delta q_1 + q_2)$, where r is interest rate.
- Total cost: $c_1(q_1, \delta)$ and $(1 + r)c_2(q_2)$.

- The longer the durability δ , the more costly is it to produce: $\partial c_1/\partial \delta > 0.$
- If the firm is to rent its product (and thus avoid Coase conjecture problem). Then its problem is

$$\max_{q_1,q_2,\delta} q_1 f_1(q_1) + (\delta q_1 + q_2) f_2(\delta q_1 + q_2) - c_1(q_1,\delta) - c_2(q_2)$$



$$f_{1} + q_{1}f_{1}' + \delta f_{2} + (\delta q_{1} + q_{2})\delta f_{2}' = \frac{\partial c_{1}}{\partial q_{1}}.$$

$$f_{2} + (\delta q_{1} + q_{2})f_{2}' = c_{2}'.$$

$$q_{1}f_{2} + (\delta q_{1} + q_{2})q_{1}f_{2}' = \frac{\partial c_{1}}{\partial \delta}.$$
(1)

Thus

$$\frac{1}{q_1}\frac{\partial c_1}{\partial \delta} = c_2'.$$
 (2)

- The marginal cost of increasing durability so that one more unit will survive the 2nd period (LHS) equals MC of producing one unit in 2nd period (RHS).
- Although (2) defines the efficient level of durability, it is not sustainable. When the second period arrives, q₁ is a given number and the firm's problem is actually

$$\max_{q_2} q_2 f_2(\delta q_1 + q_1) - c_2(q_2).$$

► FOC:

$$q_2 f_2' + f_2 - c_2' = 0. \tag{3}$$

- Comparing (3) with (1) we know that the monopolist fails to takes the term δq₁f₂' into consideration. Since q₁f₂' < 0, q₂ in (3) is greater.
- Given q_2 , we solve for q_1 and δ in the 1st period, and have

$$rac{1}{q_1}rac{\partial c_1}{\partial \delta}=c_2'+\delta q_1 f_2'rac{d(\delta q_1+q_2)}{d\delta q_1},$$

The term $\delta q_1 f'_2$ is simply the increase in production in period 2; and $\frac{dq_2}{d\delta q_1}$ is the effect of 1st period's change in choice of durability on period 2's output.

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We also can show that

$$\Delta \equiv \frac{d(\delta q_1 + q_2)}{d\delta q_1} = \frac{f_2' - c_2''}{2f_2' + q_2f_2'' - c_2''}.$$

denominator is negative by SOC.

- f₂' c₂'' < 0, which implies △> 0. This means that δ and q₂ has inverse relation. But since q₂ is greater in (3) than in (1), we know that (3) has smaller durability δ.
- Thus the monopolist chooses a lower durability to accommodate higher output in the 2nd stage.

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Since a law forbidding renting good to consumers will induce the monopolist to shorten durability of good, the law might actually reduce social welfare. This is because planned obsolescence might reduce social welfare.

E.g.

p=100 - q in both periods.

1st period unit cost: 20

2nd period unit cost: 10

Renter: $q_1 = 40$, $\delta = 1$, $q_2 = 0$

social surplus = PS + CS = 4050 + 2025 = 6075.

Seller: $q_1 = 40$, $\delta = 1/2$, $q_2 = 55$

social welfare = 3725 + 2312.5 = 6037.5.

Case of Oligopoly

- In the oligopoly case, there is a countervailing incentive to the above-mentioned planned obsolescence motive to expand durability.
- This is because higher durability ensures higher output in the 2nd period, which forces competitors to cut output, and increases own profit. Set up: n + 1 competitors.
- The problem of a firm is

 $\max_{q_1,\delta,q_2} q_1 f_1(q_1 + \overline{q_1}) + (\delta q_1 + q_2) f_2(\delta q_1 + \overline{\delta q_1} + q_2 + \overline{q_2}) - c_1(\delta, q_1) - c_2(q_2);$

where \bar{q}_1 and \bar{q}_2 are outputs of the other n firms in 1st and 2nd periods, respectively. δ is durability chosen by other firms in the 1st period.

$$f_2 + q_2 f'_2 - c'_2 = 0;$$

 $f_2 + q'_2 f'_2 - c''_2 = 0, \quad i = 1, \dots, n.$

 q_2^i is 2nd period output of the i^{th} firm.

► We thus have

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$$\frac{1}{q_1}\frac{\partial c_1}{\partial \delta} = c'_2 + \delta q_1 f'_2 \frac{d(\delta q_1 + q_2)}{d\delta q_1} + (\delta q_1 + q_2) f'_2 \frac{d\bar{q}_2}{d\delta q_1}.$$

f $\frac{d\bar{q}_2}{d\delta q_1} < 0$, then the last term is positive. This has the effect of ncreasing durability.

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Two examples:

▶ 1. A monopolist facing 2nd period entry. Suppose cost is

 $q_1c+(\delta+q_2)c.$

1st period: monopolist chooses q_1 , δ . 2nd period: Cournot competition. Demand

$$egin{aligned} & eta &= lpha - eta q_1, \ & eta &= (1+\gamma)(lpha - eta \delta q_1 - eta q_2 - eta ar q_2). \end{aligned}$$

2nd period equilibrium:

$$q_2 = \bar{q}_2 = \frac{\alpha - \beta \delta q_1 - c}{3\beta}.$$

1st period: monopolist

$$\max_{q_1,\delta} q_1(\alpha - \beta q_1 - c) + (\delta q_1 + q_2).$$

We get

$$egin{aligned} q_1 &= rac{lpha - m{c}}{2eta}, \ \ \delta &= 1/2, \ q_2 &= ar{q}_2 &= rac{lpha - m{c}}{4eta}. \end{aligned}$$

The monopolist actually chooses the monopoly output in 1st period, and produces the Stackelberg leader output in the 2nd stage. ► 2. Symmetric Oligopoly

n firms in each of 2 periods Cournot competition. Similarly, we can formulate the problem into

$$\begin{split} \max_{q_1,\delta} q_1(\alpha - \beta q_1 - \beta (n-1)\bar{q}_1 - c) \\ &+ (\delta q_1 + q_2)(\alpha - \beta (\delta q_1 + \delta (n-1)\bar{q}_1 + q_2 + (n-1)\bar{q}_2) - c) \\ \text{with } q_2 = \bar{q}_2 = \frac{(\alpha - \beta (\delta q_1 + (n-1)\delta \bar{q}_1)) - c}{\beta (n+1)} \end{split}$$

Solution:

$$q_1 = \overline{q}_1 = \frac{\alpha - c}{\beta(n+1)}$$
$$\delta q_1 = \overline{\delta q} = \frac{(\alpha - c)(n-1)}{\beta(n^2 + 1)}$$
$$q_2 = \overline{q_2} = \frac{\alpha - c}{\beta(n^2 + 1)}$$
$$\delta = \frac{n^2 - 1}{n^2 + 1}$$

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- 1. For a monopolist (n = 1), $\delta = 0$
- 2. If n = 2, $\delta = 0.6$
- 3. In general, δ increases with n
- 4. When $n \to \infty$, $\delta \to 1$.