DURABLE GOOD MONOPOLY.

Durable goods last for more than one period.

Demand is linked over time.

Suppose a monopolist has the flexibility to charge different prices over time (intertemporal price discrimination).

Downward sloping market demand curve for the durable good with price taking consumers (for example, continuum of consumers).

As a monopolist, if you sell a lot today, you reduce the demand for your own good tomorrow.

If the demand is lower tomorrow, you will have incentive to reduce your price tomorrow.

Consumers wait to buy if they believe prices will be significantly lower later (or quality higher).

Incentive to wait depends on price difference perceived and the length of time interval between price revisions.

The greater the incentive to wait, the greater the pressure to reduce price now to be able to sell today.

As a monopolist, you are competing with future versions of yourself.

Coase conjecture [Coase (J. Law Economics & Organization,1972)]:

The flexibility afforded by the ability to charge different prices over time will hurt the monopolist.

Consumers will tend to wait for lower prices in the future.

This will force the monopolist to charge lower prices today.

As the time interval between successive price revisions goes to zero, monopolist loses all market power.

In the limit, you have a competitive outcome.

Monopoly profit is lower when intertemporal price discrimination can occur.

The monopolist is much better off if he can credibly precommit to fix price at the initial level forever.

The monopolist can also do better if he leases the good instead of selling it.

Leasing converts a market for a durable good into a market for the current service from the good which is, by definition, non-durable.

A simple two period model due to Bulow (J. Political Economy, 1982):

$t = 1, 2$.

Good bought in period 1 lasts for two periods with no depreciation.

After period 2, it becomes obsolete.

Assume production cost $= 0$.

Demand for *use* of the good each period: $D(p) = 1 - p$.

[Think of this as if:

- there is a unit mass of consumers

- each consumer uses at most one unit of this good each period

- dollar valuation of this use per period is distributed uniformly between 0 and 1.]

Leasing:

No link between periods.

Monopolist sets p_t so as

$$\max_{p_t} p_t(1 - p_t)$$

i.e., sets $p_1 = p_2 = \frac{1}{2}$ and the total discounted sum of profits is $\frac{1}{4}(1 + \delta)$.

Selling with pre-commitment to not lower price in period 2:

(No intertemporal price discrimination).

Consumers who buy do so in period 1.

If quantity q is sold then the marginal consumer is one whose per period use value is $(1-q)$ and so the price charged must be:

$$p = (1+\delta)(1-q)$$

The monopolist solves

$$\max_q q(1+\delta)(1-q)$$

which yields, $q_1 = \frac{1}{2}, p_1 = \frac{(1+\delta)}{2}$ and the total discounted sum of profits is $\frac{1}{4}(1+\delta)$.

Same market outcome as leasing.

Selling (no pre-commitment):

Work backwards.

Now, there is a (second hand) resale market in period 2.

But there is no physical difference between resold and new good in period 2.

So, if q_1 ($\leq$ 1) is the quantity of goods sold by the monopolist in period 1 and q_2 is the quantity of *new* goods sold in period 2, then the price in period 2 must satisfy:

$$p_2 = 1 - (q_1 + q_2)$$

So, for any q_1, in period 2, the monopolist will set q_2 to maximize

$$[1 - (q_1 + q_2)]q_2$$

which yields:

$$q_2(q_1) = \frac{1 - q_1}{2} = p_2(q_1)$$

and the profit in period 2 is

$$\pi_2(q_1) = \frac{(1 - q_1)^2}{4}$$

Now, we go to period 1.

If monopolist sells q_1 in period 1, then the marginal consumer (the lowest valuation consumer that buys) is the one with utilization valuation equal to $(1 - q_1)$.

The highest price at which he can sell q_1 is a price $p_1(q_1)$ such that this marginal consumer is indifferent between buying the good in period 1 (and enjoying it for two periods) or waiting to buy it in period 2 at a price $p_2(q_1)$ and using it for one period:

$$\begin{aligned}(1 - q_1)(1 + \delta) - p_1(q_1) &= \delta[(1 - q_{1)} - p_2(q_1)] \\ &= \delta(\frac{1 - q_1}{2})\end{aligned}$$

so that

$$p_1(q_1) = (1 + \frac{\delta}{2})(1 - q_1)$$

The intertemporal discounted sum of profits by selling q_1 in period 1:

$$\begin{aligned} & q_1 p_1(q_1) + \delta \pi_2(q_1) \\ = \ & (1 + \frac{\delta}{2}) q_1 (1 - q_1) + \delta \frac{(1 - q_1)^2}{4} \end{aligned}$$

and maximizing this yields

$$q_1^* = \frac{2}{4 + \delta}$$

so that

$$p_1^* = \frac{(2 + \delta)^2}{2(4 + \delta)} < \frac{(1 + \delta)}{2}$$

The total discounted sum of profits:

$$[1 - \frac{\delta}{4}][\frac{2+\delta}{4+\delta}]^2$$

which is strictly less than $\frac{1}{4}(1+\delta)$, the total discounted sum of profits when the monopolist leases or sells with pre-commitment to not lower prices.

Formal version of the Coase Conjecture:

Infinitely lived monopolist with unit cost of production $c \geq 0$.

Assume there is a continuum of infinitely lived consumers with unit demand whose valuation of the durable good (the infinite horizon discounted sum of use value) is distributed on $[c, \infty)$

Prices revised at points of time of interval $\Delta > 0$. Discount factor:

$$\delta = e^{-r\Delta}$$

where r is the interest rate.

Result: As $\Delta \to 0$*, the intertemporal (discounted sum of) profit of the monopolist* $\to 0$ *and all prices converge to* c*. In the limit, almost all trades take place at the initial instant.*

Stokey (1981), Bulow (1982): Specific demand functions and equilibria.

Gul, Sonnenschein and Wilson (J. Economic Theory,1986): General demand structures.

Main arguments:

Continuum of consumers implies consumers are price taking.

They decide according to their expectation of future prices which they take as given.

Rational expectations equilibrium:

* consumers anticipate the price path to be chosen by monopolist, take this as given and buy accordingly;

* given this buying behavior, there should no incentive for the monopolist to deviate from the price path at any point.

Incentive to wait is lower for higher valuation consumers.

For example, for a consumer whose infinite horizon value of using the good is v the gain from buying today rather than tomorrow:

$$
\begin{aligned}
& (v - p_t) - \delta(v - p_{t+1}) \\
= \; & (1 - \delta)v - p_t + \delta p_{t+1}
\end{aligned}
$$

is increasing in v.

If consumer with a certain valuation buys today, all consumers with higher valuation must have bought by the end of today.

For any fixed $\Delta > 0$, equilibrium price path is non-increasing over time.

If price increases tomorrow, no one will buy tomorrow.

As Δ becomes extremely small, buyers will wait even if the price declines very slightly and so the price decline must be extremely small if you want some consumers to buy today rather than wait.

As $\Delta \to 0$, if current $p >> c$, then people anticipate price decline in very near future and wait.

So $p \to c$.

WARNING: Actual proof is much more complicated.

* The durable goods monopoly problem is equivalent to a problem of bargaining under one sided incomplete information.

* In general, monopolist can do much better by pre-committing to a sequence of prices (the optimal pre-commitment turns out to be a constant price sequence equal to the static monopoly price).

The latter also generates same profit as the leasing outcome.

Bagnoli, Salant and Swierzbinski (J. Political Economy, 1989, pp 1459-78): **Coase Conjecture does not hold with finite number of consumers who behave strategically.**

Main argument: higher valuation buyers realize how their buying decision influences future prices

and that if they wait to buy at a lower price, the monopolist will not have incentive to charge lower price

(until they have bought and left the market).

Example.

Consider a durable good that lasts two periods, $t = 1, 2$.

No depreciation, but good becomes obsolete after period 2.

Consumers have unit demand (i.e., buy at most one unit).

There are two consumers:

* a high valuation consumer whose valuation of period's use of one unit is V_H

* a low valuation consumer whose valuation of one period's use of one unit is V_L.

Assume: $V_H > 2V_L$.

Cost of production $= 0$.

Leasing outcome:

Monopolist charges $p = V_H$ every period earning profit

$$\pi^L = (1 + \delta)V_H.$$

Selling with pre-commitment about price in period 2:

Here, monopolist has to pre-commit to p_1, p_2 in period 1 and cannot condition p_2 on what happens in period 1.

If monopolist charges $p_1 = (1+\delta)V_H$ and pre-commits to $p_2 \geq V_H$, he sells only in period 1 and only to one consumer i.e., the high valuation consumer.

His profit $= (1+\delta)V_H$.

If monopolist wants to sell to both consumers in period 1, his profit is

$$\begin{aligned} & 2(1+\delta)V_L \\ < \; & (1+\delta)V_H. \end{aligned}$$

If he sells only to the high valuation consumer in period 1 and sell to the low valuation consumer in period 2, then he will charge V_L in period 2 (charging a lower price in period 2 only reduces his profit and increases the incentive of the high valuation buyer to wait for period 2).

So,in period 1, he will charge a price p_1 so as to leave the high valuation buyer indifferent between buying in periods 1 and 2:

$$(1+\delta)V_H - p_1 = \delta(V_H - V_L)$$

so that

$$p_1 = V_H + \delta V_L$$

and the profit of the monopolist is

$$\begin{aligned} & V_H + 2\delta V_L \\ < \;& (1+\delta)V_H. \end{aligned}$$

Therefore, optimal profit under selling with pre-commitment:

$$\pi^{SPC} = (1 + \delta)V_H.$$

Selling without pre-commitment:

This is a two stage game with three players.

One has to look for a subgame perfect equilibrium (SPE).

Strategy: in period 2, specify an action to be chosen for each possible history of the play (i.e., what happened in period 1).

Consider the following strategies:

Monopolist:

* charge $p_1 = (1+\delta)V_H$ in period 1;

* in period 2, charge a price equal to the highest valuation of the buyers remaining in the market.

Buyer of type i:

buy in the first period if $p_1 \leq (1+\delta)V_i, i = H, L$.

If not, wait for period 2 and buy if $p_2 \leq V_i$.

Claim: These strategies constitute a SPE.

Proof: Work backwards.

First consider period 2 and check that no player has an incentive to deviate.

Given the buyers' buying strategy, for the monopolist, it is optimal to charge $p_2 = V_H$ if the high valuation buyer is left in the market (with or without the other buyer) and to charge $p_2 = V_L$, if only the low valuation buyer is left.

So, the above mentioned strategy is clearly optimal for the monopolist in stage 2.

For each buyer that has not bought in period 1, it is optimal to buy in period 2 as long as the price does not exceed their one period use value. So, buyers' strategy in period 2 is optimal too.

Now, go back to period 1.

Each buyer knows that given the strategy of the monopolist, she can get at most zero net surplus in period 2 i.e., either p_2 will exceed her valuation or will exactly equal her valuation.

So, if $p_1 \leq (1+\delta)V_i$, it is optimal for a buyer with valuation V_i to buy in period 1.

(Note: this is the critical argument, the high valuation buyer cannot reduce the price at which she buys by waiting).

Finally, given the strategies of the buyers, the monopolist is clearly better off charging $p_1 = (1+\delta)V_H$ as the strategy of high valuation buyer says she is going to buy at that price in period 1 and, by backward induction, monopolist knows she can then sell to low valuation buyer next period at price $p_2 = V_L$.

QED.

When this equilibrium is played, the monopolist price discriminates over time (and therefore, across consumers) and the profit is

$$\pi^S = (1+\delta)V_H + \delta V_L.$$

Note:

$$\pi^S > \pi^{SPC} = \pi^L = (1+\delta)V_H$$

Thus, the Coasian problem disappears.

Selling is better than leasing.

Even without pre-commitment, monopolist makes much higher profit than leasing.

Pre-commitment to future prices not better for monopolist.

More generally, it has been shown that with any finite number of consumers, there are equilibria where the Coase conjecture does not hold. Indeed, in the infinite horizon case, there are equilibria such that as discount factor goes to one, the monopolist exercises almost perfect market power extracting almost all social surplus.

Other settings in which the Coase conjecture (and related results) may not hold:

* Decreasing returns to scale (Kahn (Econometrica, 1986)) i.e., upward sloping MC curve can convince consumers that prices cannot fall very fast (monopoly output cannot expand without raising MC that in turn acts as a floor on pricing).

* Fixed opportunity cost of staying in the market:

- monopolist exits if remaining demand is not high enough

- so price cannot fall too much in the future.

* Strong depreciation.

* Increasing marginal cost over time

(cost congestion for example, when production over time involves use of a finite stock of necessary input such as an exhaustible natural resource).

* Asymmetric Information: buyers may not know MC of seller.

Low cost seller can pretend to be a high cost seller, charge a price equal to MC of high cost seller and earn positive profit that is bounded away from zero (even if interval between price revisions are close to zero).

* Inflow of new cohorts of buyers (Conlisk, Gerstner and Sobel, Quarterly J. of Econ, 1984)

- identical cohorts enter over time

- lower valuation buyers have higher incentive to wait.

The stock of consumers waiting to buy are on the average of lower valuation than new cohort.

Monopolist has incentive to not lower price too much and sell to higher valuation new consumers,

until the stock of old lower valuation consumers become large

and at that point to have a big sale which, in turn, reduces the stock of consumers sharply and then return to high prices again.

Price cycles.

Other mitigating factors that allow durable good sellers to make money:

* Pre-commitment (third party).

* Leasing.

* Reputation:

The monopolist may establish a reputation for not cutting prices.

Initially, consumers expect monopolist charging high price to be "honorable" & not to cut prices in future

if he does cut price in any period, they revise their expectation to "he is actually a scoundrel rational seller"

i.e., one who will cut prices if it suits him

and therefore, the Coase conjecture works from that point on and drives his profit to near zero.

So, even though a rational monopolist might want to cut prices, he may find he is better off pretending to be an honorable guy and not cut prices (as that might spoil his reputation & will make him earn close to zero profit from that point onwards).

* Money back guarantee - compensate consumers for all future price declines.

Effectively, monopolist pre-commits to not cut price.

Problems in enforcement (secret price cuts, quality improvement etc).

* Planned Obsolescence:

Reducing durability reduces the quantity of goods carried over and thus convinces buyers that the price won't fall too much.

Textbook producers frequently bring out new editions to kill used books.

Got to be careful: consumers anticipate the degree of planned obsolescence and their valuation falls;

this forces seller to reduce the level of initial price. (see, for example, Waldman(Quarterly J. of Economics, 1993).

* Oligopolistic collusion: The same mechanism that allows oligopolists to collude may also allow them to precommit to not cutting prices rapidly over time.

REMARK: Coasian problems arise also when seller can innovate and improve product over time.