# 10. Market Power

- Market power is the ability of a firm to increase profits by setting a price above marginal cost.
- Most real-world firms acquire some degree of market power by producing goods that have no perfect substitutes.
- The degree of substitution between the outputs of different firms is reduced by differences in
  - product characteristics
  - location
  - customer service
  - and by informational asymmetries.



## 10.1 Perfect Competition

- In models of perfect competition every firm is assumed to be a price taker,...
- so in the competitive model, firms cannot increase profits by setting the price.
- In real-world competitive markets, any firm can set whatever price it chooses.
  - E.g., there is no law that requires the farmer to accept the market price for his crop.

- **But it would be foolish for a firm to deviate from the market price.**
  - **In competitive markets, many firms produce identical goods, and each firm serves a small share of the market.**
  - **If the firm raises its price, its sales will drop to *0*.**
  - **The firm can sell as much as it wants to at the market price, so if it reduces its price, its profits must go down.**
- **Consequently the price-taker assumption for competitive markets is without loss of generality.**



## 10.2 Monopoly

- **Stated most simply, a monopoly is a firm that is the only seller of a good.**
  - **No other firm sells the same good or a close substitute.**
- **In the standard model, monopolies do not interact strategically with other firms that sell to the same customers.**
  - **Example: Suppose Firm $A$ is the only firm that rents apartments in a neighborhood $X$.**
    - **And suppose that A's rental rate influences the profits of a large number of food shops in $X$,**
    - **but no food shop can affect the profits of Firm $A$,**
    - **then we can model $A$ as a monopoly.**
    - **Firm $A$ could choose its profit-maximizing price without regard to possible responses of food shops.**

- Example: Suppose Firm $A$ is the only firm that rents apartments in a neighborhood $X$.
  - If there were another firm $B$ that sold condominium apartments in the same neighborhood,
  - then it would be inappropriate to model firm $A$ as a standard monopoly,
  - because the pricing strategy of each firm would affect the profits of the other.
  - Firm A could not choose its profit-maximizing price without considering the pricing strategy of Firm $B$.



- Monopolies do not interact strategically with their customers.
  - The pricing strategy of a monopoly usually affects the utility of its customers.
  - But we assume the presence of a large number of small buyers,
  - so that the purchasing strategy of a single buyer does not affect the profits of the monopoly.
  - Monopolies are normally modeled as price setters,
    - (equivalently, they may be thought of as controlling quantities by setting prices),
  - but in the standard model, buyers are modeled as price takers.

## The standard monopoly model

- Let the market demand of all buyers be represented by the demand function $q = q(p)$, where buyers take the monopoly-set price $p$ as given.
  - We assume that for some $\bar{p} > 0$, $q(\bar{p}) = 0$,
  - and that $q'(p) < 0$ for $0 < p < \bar{p}$
- The monopoly faces a total cost function given by $C(q)$.
- Then the monopoly's profit function is given by

$$\pi(p) = pq(p) - C(q(p))\,.$$

- The monopoly price is given by

$$p_m = \operatorname*{argmax}_{p \geq 0} \pi(p)\,.$$



- The foc for an interior optimum is

$$q(p) + pq'(p) - C'(q)\,q'(p) = 0$$

or, keeping in mind that $q'(p) < 0$,

$$p - \frac{q(p)}{|q'(p)|} = C'(q)\,.$$

- Note that if we treat revenue $R$ as a function of quantity $q$, we can write

$$R(q(p)) \equiv pq(p)$$

and differentiating with respect to $p$ yields

$$R'(q)\,q'(p) \equiv pq'(p) + q(p)$$

so that

$$R'(q) \equiv p - \frac{q(p)}{|q'(p)|}.$$

- **Thus the foc simplifies to**

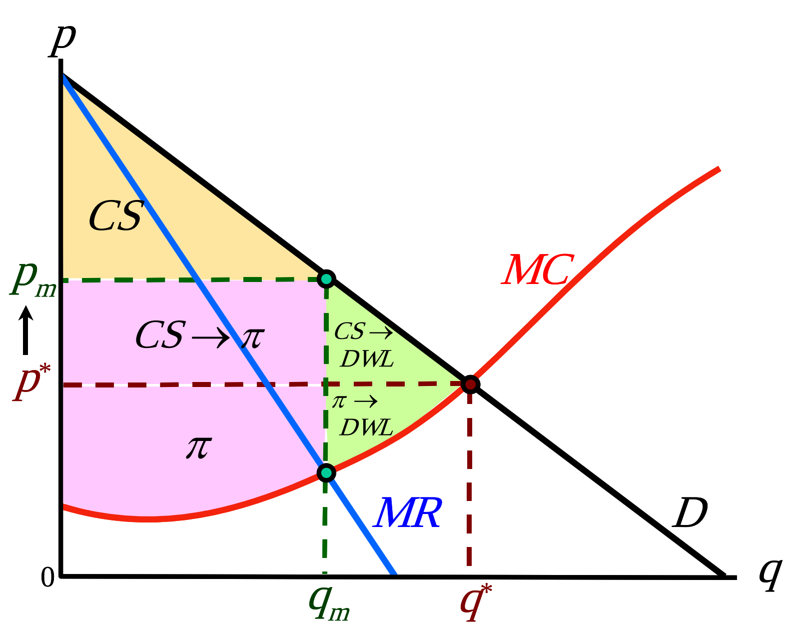
$$R'(q) = C'(q)$$

**or** $\mathrm{MR} = \mathrm{MC}$**.**

- **Then** $p_m$ **is either one of the solutions of the foc or the corner solution** $p_m = \bar{p}$ **(**$q = 0$**), whichever yields the greatest monopoly profits.**
  - **We rule out the corner solution** $p = 0$ **in advance, because at** $p = 0$ **revenues are** $0$ **and costs are maximized.**



- **In the standard graph (below), the monopolist raises her price from the competitive price** $p^*$ **to the monopoly price** $p_m$**.**
- **The monopolist captures part of consumer surplus** CS **as profits** $\pi$**.**
- **But part of the social surplus becomes deadweight loss, DWL.**



PROBLEM 40.MM. ***Suppose demand is given by***

$$q(p) = 30 - p \text{ for } 0 \leq p \leq 30$$

***and costs by***

$$C(q) = 120 \log(1 + q) \text{ for } q \geq 0.$$

***Find the monopoly price. What is the value of the deadweight loss caused by the monopoly?***

- **We can write the inverse demand function as $p = 30 - q$, so that $R(q) = 30q - q^2$ and**

$$R'(q) = 30 - 2q.$$

- **Also,**

$$C'(q) = \frac{120}{1+q}.$$



- **Therefore, any interior solutions of the profit maximization problem must satisfy**

$$30 - 2q = \frac{120}{1+q}$$

**or**

$$q^2 - 14q + 45 = 0.$$

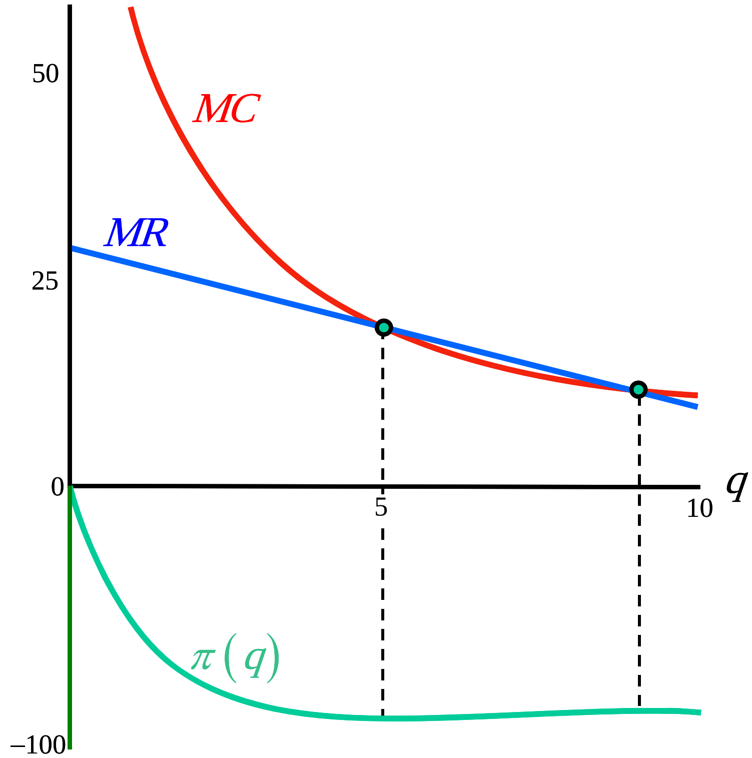
- **The solutions are $q_1 = 5$ and $q_2 = 9$.**
- **Profits are given by**

$$\pi(q) \equiv R(q) - C(q) \equiv 30q - q^2 - 120 \log(1 + q),$$

**so that $\pi(5) = -90.0$, $\pi(9) = -87.3$ and, last but not least, $\pi(0) = 0$.**

- **Therefore, $q_m = 0$ and $p_m = 30$.**

- The analysis of the example is captured on the graph below.






- Of course, all of this can be computed directly from the profit function $\pi(p)$.

- We have

$$\pi(p) \equiv pq(p) - C(q(p))$$

or

$$\pi(p) \equiv 30p - p^2 - 120 \log(31 - p).$$

- The foc is

$$30 - 2p + \frac{120}{31 - p} = 0,$$

whose solutions are $p_1 = 21$ and $p_2 = 25$.

- Both $p_1$ and $p_2$ yield negative profits, whereas the corner solution $p = 30$ $(q = 0)$ yields $0$ profits.

- The outcome of the standard monopoly model may be obtained from as the outcome of strategic interaction in a game between the monopoly and a small number of customers.
  - Consider the following-two stage game:
    - A monopolist sets the price of his good.
    - Then his customer(s) decide(s) how much to buy at those prices.
  - The subgame-perfect equilibrium yields the same results as standard monopoly model.
  - In SPE, the customer's strategy requires a best response to every possible price,
  - so the customer is a price-taker, even if he is the only customer.



## Rent-seeking

- The profit-maximizing pricing strategies of nondiscriminating monopolies cause them to be inefficient.
  - Monopolists raise the price above the competitive level in order to transfer consumer surplus to monopoly profits.
  - But this excludes consumers from the market (or limits their demand) and causes a loss of consumer surplus that is not captured by the monopolist.
- In this regard, perfectly discriminating monopolists are efficient. They can charge each buyer her willingness-to-pay.

- **Monopoly status is usually an unowned resource rather than a property right.**
- **Therefore, the attempt to achieve or maintain monopoly status is likely to waste real resources and is a separate cause of inefficiency.**
- **The use of real resources in an attempt to obtain or maintain monopoly status is a form of rent-seeking.**
- **When monopoly status is conferred as a legally enforceable property right (as with patents and copyrights), rent-seeking behavior may be discouraged...**
  - **but certainly not eliminated.**
  - **In the US, costly disputes over intellectual property rights are common.**



Definition 10.1. Rent-seeking *is the costly attempt to transfer resources from other persons to oneself.*

- **Rent seeking is inefficient in that it reduces social surplus. Why?**
- **Example: "beauty contest" for mobile telephone spectrum.**
  - **In some countries (e.g. US, UK and Germany), spectrum for the use of mobile phones was allocated by auction.**
  - **In other countries (e.g. France and Spain), spectrum was allocated in a "beauty contest" in which firms were required to convince regulators that they would provide the best service to the public.**
  - **Applicant firms spent vast sums on the beauty contest.**

- Suppose there are $n$ firms in a beauty contest of spectrum in which the winner would obtain monopoly profits $\pi$.
- Suppose the firms hire consultants, lawyers, lobbyists and publicists in order to increase their odds of winning.
- Let us assume that the probability $p$ that a given firm will win the license is given by:

$$p = \frac{x}{x+Y},$$

where $x$ is the amount the firm spends on its application, and $Y$ is the total amount that all other firms spend on their applications.



- In that case, the firm's net expected profits from the application will be

$$\tilde{\pi}(x) = p\pi - x \equiv \frac{x}{x+Y}\pi - x.$$

- The first-order condition for net-profit maximization is

$$\frac{1}{x+Y}\pi - \frac{x}{(x+Y)^2}\pi - 1 = 0,$$

- so if there is an interior maximum, the solution must be:

$$x^* = \sqrt{\pi Y} - Y.$$

- In that case, any symmetric Nash equilibrium must satisfy

$$Y = (n-1)\, x^*,$$

and, substituting, we have

$$nx^* = \sqrt{\pi(n-1)\, x^*}$$

or

$$x^* = \frac{n-1}{n^2}\pi.$$

- Each firm has an equal chance of winning, so expected net profits must be

$$\tilde{\pi}^* = \frac{\pi}{n} - \frac{n-1}{n^2}\pi \equiv \frac{\pi}{n^2} > 0,$$

which confirms that the solution for spending will be interior. Why?

- Total expected social surplus generated by the monopoly profits $\pi$ is $n\tilde{\pi} \equiv \pi/n$, so that the fraction $(n-1)/n$ of the social surplus from $\pi$ is lost to rent-seeking.



- Rent seeking may be associated with monopolies and market power in many contexts.
  - Incumbents attempt to keep entrants out of the market.
  - Entrants attempt to break into the market.
  - Efforts to prevent patent and copyright infringement.
  - Efforts to avoid or evade patent and copyright protection.
  - Patent races (part of the cost is productive).
  - Beauty contests for contracts (rather than auctions).

- **Costly rent-seeking behavior is often manifested in the costs of consultants, lawyers, lobbyists, publicists and highly-paid employees of the firms involved.**

- **Rent-seeking may, of course, may generate bribery, but bribery is a transfer and does not imply direct social costs.**

- **Empirical work suggests that losses from rent-seeking is far greater than losses from the deadweight-loss triangles.**
  - **see: James R. Hines, Jr., "Three Sides of Harberger Triangles,"** ***The Journal of Economic Perspectives*****, Vol. 13, No. 2. (Spring, 1999), pp. 167-188.**



## 10.3 Static Models of Oligopoly

- **When there is a small number of firms producing related goods for the same market (oligopoly), then interact strategically with one another.**
  - **Each firm's strategy affects the demand to all other firms.**
  - **Consumers are modeled as passive.**
  - **Game theory is the best mechanism we have to explore the strategic interaction.**
  - **About 30 years ago, game theory replaced older methods such as "conjectural variations" for exploring the behavior of oligoplists.**

- With a small number of firms producing a homogeneous good, game-theoretic results depends heavily on whether firms set prices or quantities.
- This is unlike the case of monopoly, where price-setting and quantity-setting are equivalent.
- With price-setting oligopolies, different firms can set different prices out of equilibrium, which produces extreme competition.
  - With homogeneous goods, a firm can undercut a competitor's price by $\varepsilon$ and grab the entire market, provided only that the price is above his own marginal cost.
  - Competition is less extreme if goods are differentiated and not perfect substitutes.



- With quantity-setting oligopolies, firms accept the same market price for their output, in or out of equilibrium, and that reduces the competition.
  - The market price is a function of the total quantity produced, so the strategy of each firm affects the market price.
  - Firms are price setters only indirectly, and each firm affects the price for all firms.

## Bertrand Duopoly

- Competition between two price-setting firms producing a homogeneous good.
- Firms have constant returns to scale, with $\mathrm{MC} = c$.
- Market demand is represented by a continuous demand function $q = q(p)$ defined on $\mathbb{R}_+$, where buyers take the price $p$ as given.
  - We assume that for some $\bar{p} > 0,\ q(\bar{p}) = 0$,
  - and that $q'(p) < 0$ for $0 < p < \bar{p}$



- Consumers buy only from the lowest-price firm, and if both set the same price, then they split demand equally between the firms.
  - Let $p_1$ and $p_2$ be the prices set by firms $1$ and $2$.
  - Then the demand facing firm $1$ is

$$q_1(p_1, p_2) = \begin{cases} q(p_1) & \text{for } p_1 < p_2 \\ q(p_1)/2 & \text{for } p_1 = p_2 \\ 0 & \text{for } p_1 > p_2 \end{cases},$$

  and the demand facing firm $2$ is analogous.

  - If $p = \min\{p_1, p_2\}$ ,then for any $p_1$ and $p_2$,

$$q_1(p_1, p_2) + q_2(p_1, p_2) = q(p)\,,$$

  the market demand.

- Profits for firm $1$ are:

$$\pi_1 = (p_1 - c)\, q_1(p_1, p_2)\,,$$

with $\pi_2$ analogous.

PROPOSITION 10.1. **(Bertrand Equilibrium)** ***If both firms set prices simultaneously, then $p_1 = p_2 = c$ is a unique Nash equilibrium. This means that in Bertrand equilibrium, as in pure competition, prices equal marginal cost and profits are zero.***

PROOF.

- **$p_1 = p_2 = c$ is a Nash equilibrium**
  - **At $p_1 = p_2 = c$ each firm sells $q(c)/2$ units, but earns $0$ profits, because price equals cost.**
  - **If firm $1$ raises its price, it will lose its sales and continue to earn zero profits.**
  - **If firm $1$ lowers its price, it will gain all sales and lose money on each one.**
  - **Consequently, firm $1$ has no incentive to deviate. Neither does firm $2$.**



- **No equilibrium can have $p_1 < c$ or $p_2 < c$.**
  - **In that case the firm setting the lower price (or both firms if prices were the same) would lose money and deviate.**
- **No equilibrium can have $p_1 = c$ and $p_2 > c$.**
  - **In that case, firm $1$ could raise prices to $c < p_1' < p_2$ and earn positive rather than zero profits.**
  - **Likewise, we cannot have $p_1 > c$ and $p_2 = c$ in equilibrium.**

- No equilibrium can have $c < p_1 \leq p_2$.
  - In that case firm 2 could deviate and undercut $p_1$ by a small amount with $c < p_2 < p_1$ and increase profits.
  - Likewise, $c < p_2 \leq p_1$ is not possible in equilibrium.
- This rules out every possibility for an equilibrium aside from $p_1 = p_2 = c$, which must be unique.

∎



PROBLEM 41.MM. ***Suppose that in the Bertrand Game all prices must be expressed in dollars and cents (fractions of cents are not allowed). Find a Nash equilibrium when the costs are*** $c_1$ ***and*** $c_2$ ***with*** $c_1 \leq c_2$***. Is it unique?***

# Cournot Duopoly

- Suppose that in France there are exactly two profit-maximizing firms, L'Eau and N'Eau, that produce bottled water. Their products are homogeneous.
- Firms have constant returns to scale, with $\mathrm{MC} = c$.
- The French people (who think that drinking free tap water is "pas classe") has a demand function for bottled water given by

$$q(p) = \begin{cases} a - bp & \text{for } 0 \leq p \leq \frac{a}{b} \\ 0 & \text{for } p > \frac{a}{b} \end{cases}.$$



- The two firms choose their levels of production, $q_L$ and $q_N$ simultaneously, and let the market determine the price.
- The market price will be given by the solution for $p$ of the equation

$$q_L + q_N = q(p),$$

which is

$$p = \begin{cases} \frac{1}{b}(a - q_L - q_N) & \text{for } q_L + q_N \leq a \\ 0 & q_L + q_N > a \end{cases}.$$

- To simplify the algebra without changing the character of the solution, we assume that $c = 0$.
- Profits for L'Eau are

$$\pi_L \equiv pq_L \equiv \frac{1}{b}(a - q_L - q_N)\, q_L.$$

- For $q_N \geq a$, $\pi \leq 0$ so that $q_L = 0$ must be the best response.
- For $q_N < a$, the first-order condition for profit-maximization is

$$0 = \frac{1}{b}(a - 2q_L - q_N)$$

so that if there is an interior solution, L'Eau's best response is

$$q_L = \frac{a - q_N}{2},$$

which generates positive profits and therefore dominates the corner solution $q_L = 0$.



- We have the analogous best-response function for N'Eau, so that the equilibrium must satisfy

$$q_L = \frac{a - \frac{a - q_L}{2}}{2}$$

or

$$4q_L = a + q_L,$$

which yields

$$\tilde{q}_L = \tilde{q}_N = \frac{1}{3}a,$$

so that

$$\tilde{p} = \frac{1}{3}\frac{a}{b}.$$

- It follows that

$$\tilde{p} > c\ [= 0]$$

and

$$\tilde{\pi}_L = \tilde{\pi}_N > 0,$$

which means that both the equilibrium price and profits are above the competitive level.

PROBLEM 41.MM. ***Show that in the Cournot game between $n$ identical firms,***

$$\tilde{q}_i = \frac{1}{n+1} a$$

***and***

$$\tilde{p} = \frac{1}{n+1} \frac{a}{b}.$$

***Show also that this yields the monopoly solution for $n = 1$ and approaches the competitive solutions as $n$ gets large.***



## Duopoly with Product Differentiation

- Consumers are uniformly distributed along a street, whose length is normalized to $1$.
  - We assume that $z$ consumers live on any segment of the street of length $z$.
  - Let $t$ denote a consumer's cost of round-trip travel per unit distance; i.e. a consumer's cost of travelling the distance $z$ along the street and back to his home again is $tz$.
- At each end of the street is a firm that sells spring water, $A$ on the left and $B$ on the right.
  - Both firms have zero costs.
  - The two firms compete in prices.

- **The value of a bottle of spring water to the consumer is $v$. Each consumer wants to buy at most one bottle of spring water.**
  - **If the consumer must travel the distance $z$ to buy a bottle of spring water, then his willingness to pay for it is $v - tz$.**
  - **We are free to interpret $z$ as a measure of the difference between the consumer's ideal product and the product being sold: the larger is $z$, the less he likes the product being sold.**
  - **Consequently, we can view $A$ and $B$ as firms producing two different products, with the location of consumers as a measure of their relative preferences for the two products.**



- **What is $A$'s best response to the price $p_B$ adopted by $B$?**
  - **Suppose $A$ sets price $p_A$. Let $x$ represent the distance of a consumer from $A$, so that $1 - x$ is his distance from $B$.**
  - **Assume that $v$ is very large (all consumers must buy one unit).**
  - **The consumer will buy from $A$ if $v - tx - p_A \geq v - t(1 - x) - p_B$**
  - **The person at $x = 0$ will buy from $A$ if and only if**

$$p_A \leq p_B + t$$

**where as the person at $x = 1$ will buy from $A$ if and only if**

$$p_A \leq p_B - t.$$

- So if

$$p_B - t < p_A \leq p_B + t$$

some consumers will buy from $A$ and some from $B$.

- Suppose the consumer at $\bar{x}$ is indifferent between the two firms.
- Then it must be true that

$$p_A + t\bar{x} = p_B + t(1 - \bar{x})$$

so that

$$\bar{x} = \frac{1}{2t}(p_B + t - p_A)\,.$$

- Therefore in the case that both firms have positive demand, the demand from $A$ must be $\bar{x}$ , because all the consumers with $x < \bar{x}$ will also buy from $A$.



- Therefore we can write the $A$'s demand as

$$q_A(p_A, p_B) \equiv \begin{cases} 1 & \text{for} \quad p_A \leq p_B - t \\ \frac{1}{2t}(p_B + t - p_A) & \text{for} \quad p_B - t < p_A \leq p_B + t \\ 0 & \text{for} \quad p_A > p_B + t \end{cases}$$

- $B$ sells to all consumers to whom $A$ doesn't sell, so $B$'s demand is given by

$$q_B(p_A, p_B) = 1 - q_A(p_A, p_B)\,.$$

PROBLEM 41.MM. *For this example, find $A$'s best response to $p_B$. Then find the Nash equilibria of the game between $A$ and $B$. How does the result change if $v$ is small, so that some consumers may choose not to buy from anyone? For what values of $v$ does this occur?*