# Industrial Organization

## Lecture 1: Introduction and Monopoly I

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# Course Syllabus

Three parts to the course:

1. Monopoly
   - Classical monopoly pricing
   - Price discrimination
   - Tying and bundling
2. Oligopoly models with homogeneous goods
   - Quantity competition: Cournot & Stackelberg
   - Price competition: Bertrand
   - Collusion
   - Capacity constraints
3. Oligopoly models with differentiated products
   - Horizontal product differentiation
   - Hotelling / linear city Model
   - Salop / circular city model

# Reading list

Main textbooks:

- Tirole (1988), “The Theory of Industrial Organization”
- Belleflamme and Peitz (2010, 2015), ”Industrial Organization: Markets and Strategies”

Other useful resources

- Cabral (2000, 2017), “Introduction to Industrial Organization”
- Church and Ware (2000), Industrial Organization: A Strategic Approach”

# Course Administration

→ Course Assessment

- Continuous assessment: 40%
  - Mid-terms: 15% each mid-term
  - 10% for class participation (not just attendance)
- Final exam in May: 60%

→ Exam schedule (Exams taken in class, not lectures)

- Mid Term I: Week beginning 28th February on Part I
- Mid Term II: Week beginning 4th April on Part II
- Final Exam: 25th May 2022 – 15-18hrs

# Course Administration

→ Office Hours

- Hours: Monday, 17:00 - 19:00
- Room: 15.2.53
- Email: acrawfor@eco.uc3m.es
- E-mail me beforehand to arrange a slot

→ Course materials for this group will be posted on 'Aula Global'

# Lecture I: Overview

- Introduction: What is IO?
- Monopoly: simple model
  - Optimal price / quantity
  - Features of monopoly pricing
  - Welfare and efficiency
- Readings
  - Tirole: pp 6-13, 65-69
  - PB: pp 1-8, 24-28

# Competitive benchmark

Before starting discussion of Industrial Organization it is useful to recall some key features of competitive equilibrium (CE)

1. Exhaustive list of goods, consumers and technologies
2. Perfect market conditions
    - No externalities
    - No public goods
    - Symmetric information for buyers and sellers
    - Price taking behaviour
    - No search frictions or transactions costs

# Competitive Equilibrium Properties

Properties of CE in perfectly competitive markets

1. Supply = Demand
2. Price = Marginal Cost
3. Equilibrium is pareto efficient
   - Can't make anyone better off without making someone else worse off
   - Equilibrium outcomes maximise total welfare

$\rightarrow$ Is what we observe in the real-world consistent with CE?

# Evidence for perfectly competitive equilibrium?

**Q. Does Price = Marginal Cost (i.e. no market power)?**

$\rightarrow$ In most industries, firms have the ability to charge (and sustain) price above marginal cost. That is, they have some degree of market power

1. Monopolies (i.e. Facebook, water companies)
2. Oligopolies (i.e. soft drinks, alcohol, laundry detergent)
3. Monopolistic competition (i.e. local shopkeepers, restaurants)

**Q. Observe violations of other features of CE?**

- Asymmetric information (i.e. second hand cars, insurance, etc)
- Transaction costs (i.e. cost of searching for products, switching costs)
- Externalities (i.e. network industries)

# What is Industrial Organization?

IO studies the causes and consequences of market power

1. Theory: we will learn core concepts in this course
2. Empirical analysis
   - Measure market power
   - Empirical estimation of demand models
   - Quantify effects of changes in the economic environment
3. Policy intervention?
   - Regulation (i.e. water, gas, electricity, airlines EU 261)
   - Antitrust (i.e. collusion, mergers, abuse of dominance)
   - Tax policy (i.e. cigarettes, alcohol, sugar, ... )

# Analysing markets

To address these complexities focus on partial equilibrium analysis in which a good (or group of related goods) is singled out and interaction with rest of economy is ignored.

- Focus on interactions between firms as sellers and consumers (or other economic agents) as buyers in market
- Focus on markets with substantial market power (i.e. monopoly, oligopolies)
- Want to be able to predict market allocation to assess efficiency and welfare

# Monopoly

Why do monopolies exist? Usually some barriers to entry:

1. Natural monopoly: increasing returns to scale over relevant output range. Perhaps high up front sunk costs, capital investment (i.e. airports, electricity generation)
2. Networks: benefits to consumers depends on other consumers using the good. So a single firm serving the whole market has an advantage over many smaller firms serving a part of the market (i.e. facebook, operating systems)
3. Other barriers to entry
   - Government mandated monopoly: (i.e. train tracks, radio spectrum)
   - Legal barriers: patents or copyright law (i.e. Pharmaceuticals)
   - Resource ownership: (i.e. minerals)

# A simple monopoly model

Begin study of monopoly with a simple model. Assume:

1. The monopolist produces a single product: both costs and revenues depend on the price and quantity of this product.
2. Myopic profit maximisation: current price and quantity choices are assumed not to impact on future profits, demand or consumer welfare.
3. Anonymous and 'linear' pricing: all consumers face the same prices and any consumer purchasing $q$ units of the good the expenditure $e = pq$ . That is, there is no price discrimination, no quantity discounts.
4. No strategic interactions: model of a single firm taking economic environment as given and there is no possibility of entry by rivals or strategic interactions.

# A simple monopoly model

One firm produces quantity $q$ of a single good selling it at price $p$

- The market demand curve

$$q = Q(p)$$

  with $Q'(p) < 0$
- The inverse market demand curve:

$$p = Q^{-1}(q) = P(q)$$

- The total cost function is $C(q)$ with non-decreasing marginal cost $C'(q) \geq 0$

# Profit maximisation: choosing quantity

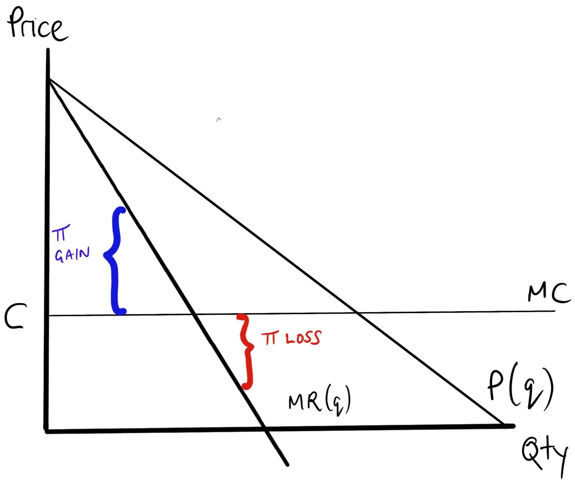
The firm chooses the amount of quantity to produce by maximising profit

$$\max_{q\geq 0} \pi(q) = \max_{q\geq 0} \underbrace{qP(q)}_{\text{Revenue}} - \underbrace{C(q)}_{\text{Total Cost}}$$

Solve first-order conditions (FOC) for optimal quantity, $q^m$:

$$\underbrace{q^m \frac{\partial P(q^m)}{\partial q} + P(q^m)}_{\text{Marginal Revenue}} - \underbrace{\frac{\partial C(q^m)}{\partial q}}_{\text{Marginal Cost}} = 0$$

# Marginal Cost = Marginal Revenue



# Back to FOC...

Rewriting FOC we can derive the Lerner equation

$$\underbrace{\frac{P(q^m) - \frac{\partial C(q^m)}{\partial q}}{P(q^m)}}_{\text{Optimal mark-up / "Lerner Index"}} \quad = \quad \frac{1}{|\varepsilon|}$$

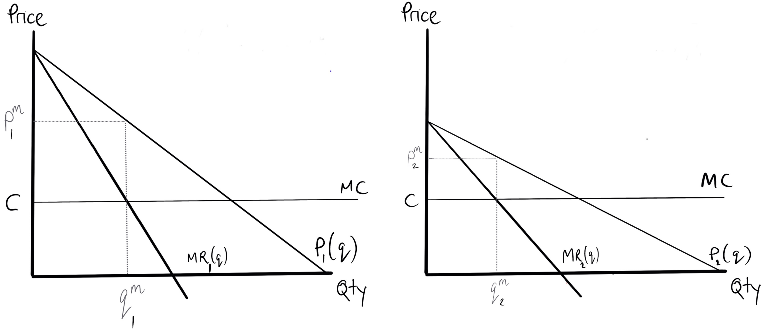
where $\frac{1}{|\varepsilon|} = \left| \frac{\partial P(q^m)}{\partial q} \frac{q^m}{P(q^m)} \right|$ is the absolute value of the inverse price elasticity of demand evaluated at $q = q^m$

$\rightarrow$ Key result

- Inverse relationship between market power and price elasticity of demand
- Pervasive in analysis of IO pricing

# Market power and the price elasticity of demand

Two industries with same constant MC but different demand curves




- $p_1^m > p_2^m$ because demand curve in industry is more inelastic
- More inelastic demand $\rightarrow$ more market power, higher margin

# Deriving the Lerner Index

Formally, starting from FOC:

$$\begin{aligned}
q^m \frac{\partial P(q^m)}{\partial q} + P(q^m) - \frac{\partial C(q^m)}{\partial q} &= 0 \\
\Longrightarrow \; P(q^m) - \frac{\partial C(q^m)}{\partial q} &= -q^m \frac{\partial P(q^m)}{\partial q} \\
\Longrightarrow \; \frac{P(q^m) - \frac{\partial C(q^m)}{\partial q}}{P(q^m)} &= -\frac{q^m}{P(q^m)} \frac{\partial P(q^m)}{\partial q} \\
\Longrightarrow \; \frac{P(q^m) - \frac{\partial C(q^m)}{\partial q}}{P(q^m)} &= \frac{1}{|\varepsilon|}
\end{aligned}$$

FOC necessary, not sufficient $\rightarrow$ check second order conditions (SOC) that $q^m$ is a (local) maximum

# Second-order conditions (SOC)

Any $q^m$ that solves FOC and satisfies the monopolists SOC is a local optimum.

The second order conditions are:

$$q^m \frac{\partial^2 P(q^m)}{\partial q^2} + 2\frac{\partial P(q^m)}{\partial q} - \frac{\partial^2 C(q^m)}{\partial q^2} \quad < \quad 0$$

- An output choice $q^m$ satisfying both FOC and SOC is a global optimum if no other local optimum satisfies the SOC
- With $N$ candidate output choices, $\{q_1^m, \dots, q_N^m\}$, plug in candidate into the profit equation and $q^m = \arg\max_{q_i^m} \{\pi(q_1^m), \dots, \pi(q_N^m)\}$

# Monopoly: choosing prices I

Monopoly faces industry demand: doesn't matter whether choose quantity or price

$$\max_p \pi(p) \quad = \quad \max_p pQ(p) - C(Q(p))$$

As with quantity choice, rewriting FOC we can derive the Lerner equation

$$\underbrace{\frac{p^m - \frac{\partial C(q^m)}{\partial q}}{p^m}}_{\text{Optimal mark-up / "Lerner Index"}} \quad = \quad \frac{1}{|\varepsilon|}$$

where $\varepsilon = \frac{\partial Q(p^m)}{\partial p}\frac{p^m}{Q(p^m)}$ is the price elasticity of demand evaluated at $p = p^m$

- Same optimal quantity-price pair: $(q^m, p^m) = (Q(p^m), P(q^m))$

# Monopoly: choosing prices II

Formally, FOC w.r.t. price (i.e $p^m$ that solves $\frac{\partial \pi}{\partial p} = 0$):

$$
\begin{aligned}
Q(p^m) + \frac{\partial Q(p^m)}{\partial p} p^m - \frac{\partial C(q^m)}{\partial q} \frac{\partial Q(p^m)}{\partial p} &= 0 \\
\implies \frac{\partial Q(p^m)}{\partial p} \left( p^m - \frac{\partial C(q^m)}{\partial q} \right) &= -Q(p^m) \\
\implies \frac{p^m - \frac{\partial C(q^m)}{\partial q}}{p^m} = -\frac{1}{\frac{\partial Q(p^m)}{\partial p} \frac{p^m}{Q(p^m)}} &= \frac{1}{|\varepsilon|}
\end{aligned}
$$

# Features of monopoly I

Absent a price ceiling, a monopolist optimally choose quantity (or price) in the elastic part of the demand curve, $|\varepsilon| \geq 1$

To see this, return to quantity setting and re-write marginal revenue,

$$MR(q) \quad = \quad P(q)\left(1 - \frac{1}{|\varepsilon(q)|}\right)$$

where $\varepsilon(q) := \left(\frac{q}{P(q)}\frac{\partial P(q)}{\partial q}\right)^{-1}$ is the inverse price elasticity of demand as a function of quantity chosen by the monopolist

# Features of monopolist pricing II

Now suppose that $q = \tilde{q}$ such that:

- $P(\tilde{q}) > 0$
- $|\varepsilon(\tilde{q})| < 1$

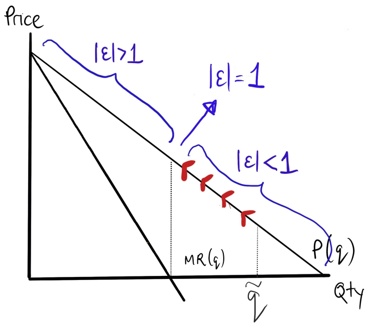
Then, marginal revenue at $q = \tilde{q}$

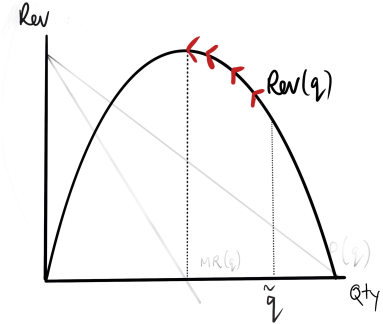
$$MR(\tilde{q}) = \underbrace{P(\tilde{q})}_{>0}\underbrace{\left(1 - \frac{1}{|\varepsilon(\tilde{q})|}\right)}_{<0} < 0$$

$\rightarrow$ Intuition: When $|\varepsilon(q)| < 1$ then $\left|\frac{\Delta q}{q}\right| < \left|\frac{\Delta p}{p}\right| \implies$ Increase revenue by reducing quantity

# Features of monopolist pricing III

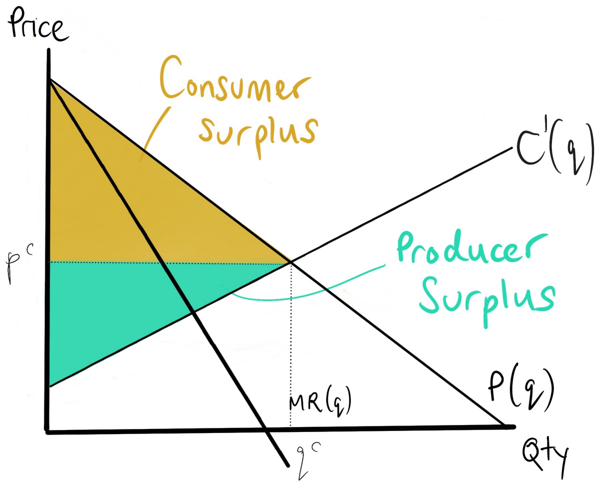
→ Illustrate using special case of linear demand: $P(q) = a - bq$.



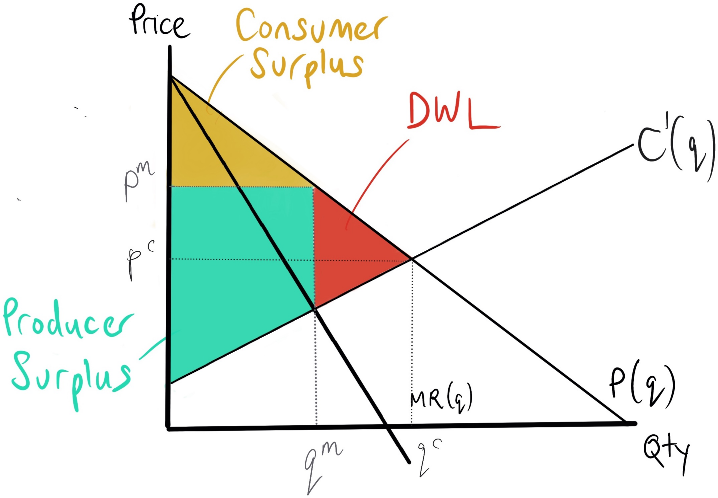
# Welfare and efficiency: Social optimum

- Total Welfare: $TW^c = CS^c + PS^c$



# Welfare and efficiency: Monopoly

- Total welfare: $TW^m = CS^m + PS^m$
- $DWL = TW^c - TW^m = \Delta CS + \Delta PS$



# Take-aways

$\rightarrow$ IO: study of causes and consequences of market power

- Market power is the ability to charge (and sustain) price > marginal cost

$\rightarrow$ Simple monopoly model

- Lerner Index: mark-up inversely linked to own-price elasticity of demand
- Monopolist faces industry demand curve
  - Doesn't matter whether set price or quantity
- Unconstrained monopolist prices in elastic portion of the demand curve
- Welfare loss relative to social optimum
  - Price $\uparrow$, Quantity $\downarrow$, Welfare loss
  - Some consumers not served under monopoly (i.e. $q^m < q^c$)