ECN 594: Introduction and Foundations

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Plan for today

1. What is industrial organization?
2. Course structure and logistics
3. Review: Monopoly pricing
4. Monopoly regulation

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5. Why do we need demand models?
6. Ordinal vs cardinal utility
7. Random utility framework
8. The dimensionality problem

Part 1: Introduction and Pricing

Your economics education so far

- So far in your economics courses you have studied (at least) two forms of competition: **perfect competition** and **monopoly**.
- We can think of these two forms of competition as polar opposites.
- **Perfect competition** (supply and demand)
  - Many tiny 'atomistic' firms
  - Total surplus is maximized and so the market is 'efficient'
- **Monopoly**
  - One single firm
  - Monopoly sets price 'too high'; the market is inefficient

Most real-world markets do not fit neatly into these two categories

- Some examples in this course:
    1. Firms set different prices for the same good (airline tickets, student discounts)
    2. Only a few big firms in the market (health insurance, tech)
    3. Firms collude to raise prices (OPEC, cartels)
    4. Firms merge with other firms (subject to **antitrust** laws)

What is industrial organization (IO)?

- **IO is the study of firm and consumer behavior in markets between (and including) the polar opposites of perfect competition and monopoly.**
- Why is this useful?
  1. Designing regulation/antitrust policy:
     - When do markets fail? How should we regulate?
  2. Firm strategy:
     - How to set prices? Design marketplaces?

IO is central to many policy debates right now

- Should we break up Google, Amazon, Meta?
- Are hospital mergers raising healthcare costs?
- Can algorithms learn to collude?
- How should we regulate AI platforms?

These are all IO questions.

This course has two components

- **Theoretical:** Models of pricing, oligopoly, entry, mergers, vertical relationships
- **Empirical:** Demand estimation, merger simulation
- The empirical content (demand estimation) is typically taught at the PhD level
- But it's so useful in practice that we cover it here
- You'll estimate demand using Python and the `pyblp` package

Course structure

1. **Part 1 (Lectures 1-7):** Demand Estimation and Pricing
   - Random utility models, logit demand
   - Identification, instrumental variables
   - Estimation with `pyblp`
   - Price discrimination
2. **Part 2 (Lectures 8-14):** Competition and Industry Structure
   - Cournot, Bertrand, Hotelling
   - Entry, mergers, collusion
   - Vertical relationships

Logistics

- E-mail: `nvreugde@asu.edu`
- Office: CRTVC 455G
- Office Hours: See syllabus
- **Textbook:** Cabral, *Introduction to Industrial Organization* (2nd ed.)
- For demand estimation: selected readings (posted on Canvas)

Assessment

- **20%** Homework 1 (demand estimation, Python)
- **20%** Homework 2 (competition models, merger simulation)
- **30%** Midterm (Feb 9)
- **30%** Final (Mar 4)
- Exams: 70 minutes, calculator + one two-sided cheat sheet allowed

Building on your prior courses

- From **ECN 565** (Alvin Murphy): Discrete choice econometrics
  - You know logit, probit, MLE
  - We'll apply this to IO problems
- From **ECN 532** (Hector Chade): Game theory
  - You know Nash equilibrium, Cournot, Bertrand, repeated games
  - We'll do quick refreshers and focus on IO applications

Optimal pricing for a monopolist

- Now let's discuss **optimal pricing for a monopolist**.
- The 'optimal price' is the **price which maximizes profit**.
- Why is this useful?
  - Policymakers: understand how the monopolist is reducing welfare
  - Firm strategy: how should you set prices to maximize profits?
- (Most of this is review from your previous courses)

Pricing: MR=MC

- The optimal price for a monopolist occurs when:

$$MR = MC$$

- This is a very important formula.
- **Algorithm to find optimal price:**
  1. Get MR from the demand curve (use 'double the slope' if linear)
  2. Set MR = MC; solve for optimal quantity q^*
  3. Plug q^* back into demand curve to get optimal price p^*

Worked example: Monopoly pricing

- **Question:**

- Suppose a monopolist faces demand $q = 2 - \frac{1}{5}p$ and has constant marginal cost of 5. What is the optimal price?

Take 2 minutes to solve this.

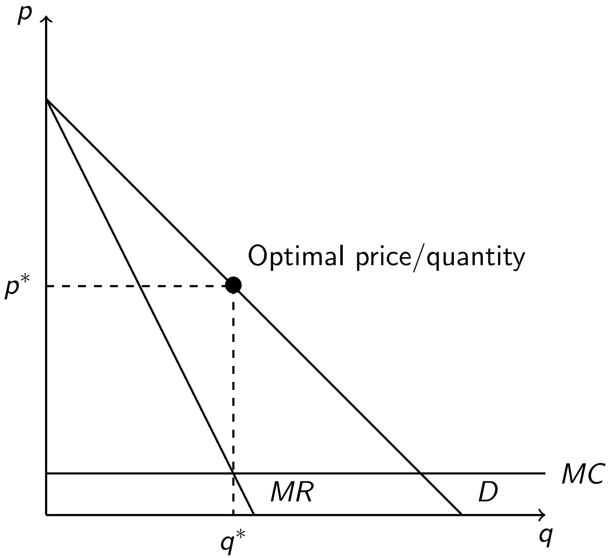
Worked example: Monopoly pricing (solution)

- **Solution:**
- First, invert demand: $p = 10 - 5q$
- MR using 'double the slope': $MR = 10 - 10q$
- Set MR=MC:

$$\underbrace{10 - 10q}_{MR} = \underbrace{5}_{MC}$$

- Solve for optimal quantity: $q^* = 0.5$
- Plug into demand curve: $p^* = 10 - 5 \times 0.5 = 7.5$

Pricing: MR=MC (graph)



The Lerner Index

- There is a relationship between the optimal price and demand elasticity.
- This is known as the **Lerner index** (or elasticity rule):

$$L = \underbrace{\frac{p - MC}{p}}_{\text{Margin}} = \underbrace{\frac{1}{|\varepsilon|}}_{\text{Inverse elasticity}}$$

- The Lerner index measures **market power**
- $L = 0$: perfect competition (price $=$ MC)
- L close to 1: high market power

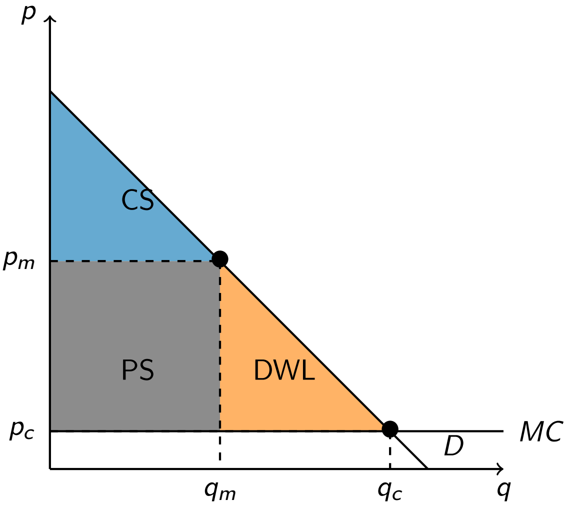
Why is the Lerner index useful?

- Suppose you work as an economist in a firm pricing a product.
- You know MC. You can estimate the demand elasticity ε.
- Then just plug into the elasticity rule:

$$p = \frac{MC}{1 + \frac{1}{\varepsilon}}$$

- This is exactly what we'll do in Part 1 of this course:
  - Estimate demand $\rightarrow$ get elasticities $\rightarrow$ compute optimal prices

Welfare costs of monopoly pricing



- Competitive outcome: p_c, q_c
- Monopoly outcome: p_m, q_m
- Monopoly sets price 'too high' and quantity 'too low'
- This causes **deadweight loss** (DWL)
- Monopoly is a **market failure**

Regulating monopolies

- How can we correct the market failure of monopoly?
- **Option 1:** Break up the monopoly (antitrust)
  - Standard Oil (1911), AT&T (1984)
  - Current debates: Google, Meta, Amazon
- Sometimes breaking up isn't possible (natural monopolies)
  - Power plants, bridges, water utilities
  - High fixed costs make one firm efficient
- How should we regulate these natural monopolies?

Marginal cost pricing

- **Idea:** Force the monopolist to set $p = MC$
  - This is the competitive price; no deadweight loss
- **Problem:** Suppose cost is $C(q) = F + cq$ (fixed cost + marginal cost)
- If $p = MC = c$, then profit is:

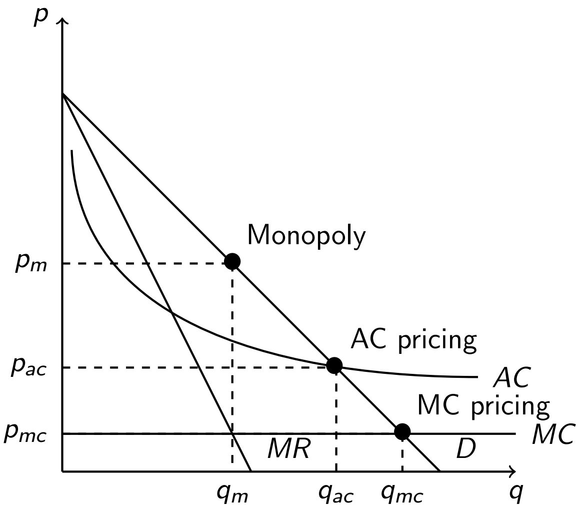
$$\pi = pq - F - cq = cq - F - cq = -F < 0$$

- Firm makes **negative** profit and would shut down!
- Solution: government **subsidy** of F

Average cost pricing

- **Alternative:** Force the monopolist to set $p = AC$
- This is the price where the monopolist makes zero profit:
  - If $\pi = 0$ then $TR = TC$
  - So $pq = TC$, which means $p = TC/q = AC$
- The monopolist can only exercise market power to cover fixed costs
- No government subsidy needed
- Commonly used for utilities ("rate of return regulation")

Average cost pricing (graph)



Price caps

- **Price cap regulation:** Set a maximum price the firm can charge
- Often indexed to inflation ("CPI-X" regulation)
  - Price can rise with inflation, minus an efficiency factor X
- Advantage: incentivizes cost reduction
  - Under AC pricing, firm has no incentive to cut costs
  - Under price caps, cost savings become profit
- Common in UK utilities, telecoms

Part 2: Utility Models and Demand

Why is estimating demand useful?

- Quantifying market power (think: Lerner index)
- Effects of a merger on prices
- Value of new goods
- Any question about consumer welfare
- Numerous other applications: school choice, health insurance, etc.

Why is estimating demand useful?

- Recall: Lerner index $L = (p - MC)/p = 1/|\varepsilon|$
- To compute market power, we need the **demand elasticity** ε
- How do we get the elasticity?
- We need to **estimate demand**
- This is one of the key empirical methods in IO

Ordinal vs cardinal utility

- **Ordinal utility:** only rankings matter, not magnitudes
  - $U(A) > U(B)$ means I prefer A to B
  - But "$U(A) = 2 \times U(B)$" has no meaning
- This is the standard microeconomics assumption
- **Problem:** We want to measure consumer surplus in \$!
  - "How much better off are consumers from this policy?"
  - Need utility to have a meaningful *scale*

Quasi-linear utility makes utility cardinal

- **Solution:** Assume quasi-linear utility

  $$U = u(\text{goods}) + y$$

  where y is income (or "money left over")

- Take the derivative with respect to income:

  $$\frac{\partial U}{\partial y} = 1$$

- The **marginal utility of income is constant** (and equals 1)

- This means we can measure utility in dollars!

Why this matters

- With quasi-linear utility:
  - 1 util $=$ \$1
  - Consumer surplus has a meaningful interpretation
  - We can add up utility across consumers
- This is the standard assumption in IO demand estimation
- (In contrast to general equilibrium models where income effects matter)

Random utility framework (refresher from ECN 565)

- Consumer i chooses among J products
- Utility of consumer i for product j:

$$u_{ij} = V_{ij} + \varepsilon_{ij}$$

- V_{ij}: deterministic component (observed by econometrician)
- ε_{ij}: random component (taste shock)

Random utility framework

- Consumer i chooses product j if:

$$u_{ij} > u_{ik} \quad \text{for all } k \neq j$$

- Choice probability:

$$P(i \text{ chooses } j) = P(u_{ij} > u_{ik} \text{ for all } k)$$

- Different assumptions on ε_{ij} give different models:
    - Type I Extreme Value $\rightarrow$ **Logit**
    - Normal $\rightarrow$ **Probit**
- You covered this in ECN 565; we'll apply it to IO

Discrete choice in IO

- In IO, we typically write:

$$u_{ij} = x_j\beta - \alpha p_j + \xi_j + \varepsilon_{ij}$$

- x_j: observed product characteristics (size, horsepower, etc.)
- p_j: price
- ξ_j: unobserved product quality
- ε_{ij}: idiosyncratic taste shock
- $\alpha > 0$: price coefficient (enters negatively!)

What is ξ_j?

- ξ_j = unobserved product quality
- Examples:
  - Brand equity ("I just like Toyota")
  - Advertising effects
  - Design/style
  - Reputation
- Key insight: firms *observe* ξ_j when setting prices!
- This creates an endogeneity problem (more on this next lecture)

Why isn't income in the utility function?

- You might expect: $u_{ij} = x_j\beta + \alpha(y_i - p_j) + \xi_j + \varepsilon_{ij}$

- But we write: $u_{ij} = x_j\beta - \alpha p_j + \xi_j + \varepsilon_{ij}$

- **Why?**

- With quasi-linear utility, income enters linearly

- When comparing alternatives, income *cancels out*:

$$\begin{aligned} u_{ij} - u_{ik} &= [x_j\beta + \alpha(y_i - p_j) + \xi_j + \varepsilon_{ij}] \\ &\quad - [x_k\beta + \alpha(y_i - p_k) + \xi_k + \varepsilon_{ik}] \\ &= (x_j - x_k)\beta - \alpha(p_j - p_k) + (\xi_j - \xi_k) + (\varepsilon_{ij} - \varepsilon_{ik}) \end{aligned}$$

- Only *differences* matter for choice, and y_i drops out

The outside option

- Important: Consumers can choose **not to buy** any product
- This is the **outside option** (product 0)
- Utility of outside option:

$$u_{i0} = \varepsilon_{i0}$$

- We normalize non-idiosyncratic components to 0
- All other utilities are *relative* to the outside option
- Why this matters:
    - If prices rise, consumers can "exit" the market
    - This affects elasticities and market power

The dimensionality problem

- Suppose we have J products in the market
- What do we need to describe demand fully?
- **Own-price elasticities:** J elasticities
- **Cross-price elasticities:** $J \times (J-1)$ elasticities
- Total: J^2 elasticities!
- For $J = 100$ products: 10,000 elasticities to estimate

The dimensionality problem: solution

- **Key idea:** Products are bundles of characteristics
- Consumers have preferences over characteristics, not products

$$u_{ij} = x_j \beta - \alpha p_j + \xi_j + \varepsilon_{ij}$$

- Instead of J^2 elasticities, we estimate:
  - K coefficients on characteristics (β)
  - 1 price coefficient (α)
- Cross-price elasticities come out of the model structure
- Products with similar characteristics are close substitutes

Example: Cars

- Product characteristics x_j:
    - Size (length, weight)
    - Horsepower
    - Fuel efficiency (MPG)
    - Air conditioning, etc.
- A Honda Civic and Toyota Corolla have similar characteristics
- $\Rightarrow$ They are close substitutes
- A Honda Civic and BMW 7-Series have different characteristics
- $\Rightarrow$ They are not close substitutes
- This structure comes from the model, not from estimating J^2 elasticities

Key Points

1. **IO** studies firm behavior between perfect competition and monopoly
2. This course has **theory** (pricing, oligopoly) and **empirical** (demand estimation) components
3. **Monopoly pricing:** $MR = MC$; Lerner index $L = (p - MC)/p = 1/|\varepsilon|$
4. Monopoly causes **deadweight loss**; regulation options include MC pricing, AC pricing, price caps
5. **Demand estimation** is central to IO: elasticities $\rightarrow$ market power $\rightarrow$ policy
6. **Quasi-linear utility** makes consumer surplus measurable in \$
7. **Random utility:** $u_{ij} = x_j\beta - \alpha p_j + \xi_j + \varepsilon_{ij}$
8. **Characteristics-based models** solve the dimensionality problem

Next time

- **Lecture 2:** The Logit Model and Identification
  - Logit derivation and elasticity formulas
  - Why price is endogenous
  - Instrumental variables