

# Introduction to empirical industrial organization

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- 1 Questions  
Examples
- 2 Methodology
- 3 Structural empirical models in IO  
Economic Model  
Econometric specification  
Example: Bresnahan and Reiss (1991)

# References

- **Aguirregabiria (2021) chapter 1**
- **Hortaçsu and Joo (2023) chapter 1**
- **Berry, Gaynor, and Scott Morton (2019)**

# Section 1

## Questions

# Industrial organization

- Structure of industries in the economy
- Behavior of firms
- Departures from perfect competition
  - Strategic behavior
  - Scale economies
  - Transaction costs
  - Information frictions
- Impact on firms' profits and consumers' welfare

# General Approach

- Model how profits and welfare are influenced by “exogenous” factors such as:
  - Demand
  - Technology
  - Institutional features and regulation

# General Approach

- Interested in:
  - **Market structure:** number of firms and their respective market shares
  - **Market power:** ability of firms to earn extraordinary profits

# General Approach

- Useful for:
  - Firm managers for e.g. choosing prices, evaluating a merger, predict the effect of introducing a new product, etc.
  - Governments for e.g. choosing how to regulate natural monopolies, identifying and punishing anti-competitive behavior, predicting the effects of taxes and environmental policy, etc



- These three examples come from [Aguirregabiria \(2021\)](#)
- **New product:** A company is considering launching a new product, e.g., a new smartphone.
  - Goal: choose price and estimate profits
  - Needs to predict demand and response of other firms
  - Data on sales, prices, and product attributes along with methods from this course can be used

- **Environmental policy:** A government imposes new restrictions on the emissions of pollutants from factories in an industry.
  - New policy encourages adoption of a new cleaner technology
  - Changes cost structure, which will affect competition
  - E.g. if the new technology reduces variable costs but increases fixed costs, then expect a decline in the number of firms and an increase in the average size (output) of a firm in the industry
  - Data on prices, quantities, and number of firms in the industry, together with a model of oligopoly competition, we can evaluate the effects of this policy change in the industry on both firms and consumers

- **Intel-AMD duopoly:** in the CPU market has lasted many years with clear leadership by Intel with more than two-thirds market share.
  - Questions: why has market structure and market power been so persistent?
  - Possibilities: large sunk entry costs and economies of scale, learning-by-doing, consumer brand loyalty, or predatory conduct and entry deterrence
  - Data on prices, quantities, product characteristics, and firms' investment in capacity allow us to measure the contribution of these factors

## Section 2

# Methodology

# Methodology

Empirical industrial organization has a distinct methodology, focusing on structural economic models

- Complete economic model tailored to the question and industry being studied
- Econometric model closely tied to economic model
- Trade off between breadth of questions you can answer and strength of assumptions

# Historical approaches to empirical IO

- 1940s and earlier: case studies
  - Careful descriptions of specific industries, firms, or events
  - Little quantification or formal tie to theory

# Historical approaches to empirical IO

- 1950s-1970s: structure-conduct-performance
  - Cross-industry regressions relating market structure to market outcomes
  - E.g. regress Lerner index,  $(P - MC)/P$ , on Herfindahl-Hirschman index,  $\sum_{i=1}^N \text{share}_i^2$

# Historical approaches to empirical IO

- Drawbacks of regressing markup on HHI (might seem obvious, but [Miller et al. \(2022\)](#) recently needed to point out again):
  - **Does not identify causal effect**
  - Ignores industry heterogeneity
  - Increased concentration can be welfare improving if due to increased elasticity of substitution (say from reduced search costs), technological change that results in greater increasing returns to scale
- Some recent resurgence looking at changes in market power and competition, e.g. [Grullon, Larkin, and Michaely \(2019\)](#), [Covarrubias, Gutiérrez, and Philippon \(2020\)](#)
- See [Berry, Gaynor, and Scott Morton \(2019\)](#) for critique



# Historical approaches to empirical IO

- Late 1980s-present: new empirical industrial organization
  - Analyses of individual industries
  - Empirical analysis framed in terms of an economic theory of the relevant industry or a set of competing theories

## Section 3

# Structural empirical models in IO

# Ingredients of a structural economic model in IO

- 1 Question
- 2 Economic model
  - Key features of the industry that are important to answer our empirical question
  - Should not be needlessly complicated
- 3 Data
- 4 Econometric specification of model
  - Economic models are deterministic and will never match data, so need to add heterogeneity and/or shocks
- 5 Estimation
- 6 Reporting of results

# Model ingredients 1

- 1 Description of the economic environment
  - 1 the extent of the market and its institutions;
  - 2 the economic actors; and
  - 3 the information available to each actor.
- 2 List of primitives
  - 1 technologies (e.g., production sets);
  - 2 preferences (e.g., utility functions); and
  - 3 endowments (e.g., assets).
- 3 Variables exogenous to agents and the economic environment
  - 1 constraints on agents' behavior; and
  - 2 variables outside the model that alter the behavior of economic agents
- 4 Decision variables, time horizons and objective functions of agents, such as:
  - 1 utility maximization by consumers and quantity demanded; and

## Model ingredients 2

- ② profit maximization by firms and quantity supplied.
- ⑤ An equilibrium solution concept, such as:
  - ① Walrasian equilibrium with price-taking behavior by consumers; and
  - ② Nash equilibrium with strategic quantity or price selection by firms.

# Econometric specification 1

- Economic models are deterministic and will never match data, so need to add heterogeneity and/or shocks
  - Unobserved heterogeneity
    - E.g. firms vary in their productivity
    - Must clearly specify to whom what is observed/unobserved – e.g. all firms' productivities are unobserved by the econometrician, and firms observe their own productivity but not others
  - Optimization errors
  - Measurement errors
- Functional forms and distributional assumptions
  - Economic models involve utility, profit, etc. functions of unknown form. For estimation we often restrict functions and distributions to be of a known parametric form.
    - Reasons: (i) computational tractability, (ii) limited data size, (iii) identification (often questionable)

## Econometric specification 2

- E.g. utility CRRA, Cobb-Douglas production function, productivity log-normal, etc
- Identification: given the distribution of the observed data, is there a unique value of model parameters that match that distribution?

# Example: Bresnahan and Reiss (1991)

- Can learn a lot from market entry with very limited data
- Cross-section of isolated markets where we observe
  - Number of firms
  - Some market characteristics (prices and quantities not needed)
- Identify:
  - Fixed costs
  - Degree of competition:  $\text{payoffs} = f(\text{number of firms})$



# Setting

- Questions:
  - Degree of competition: how fast profits decline with  $n_m$
  - How many entrants needed to achieve competitive equilibrium (contestable markets)
- Data:
  - Retail and professional industries (doctors, dentists, pharmacies, car dealers, etc.), treat each industry separately
  - $M$  markets
  - $n_m$  firms per market
  - $S_m$  market size
  - $x_m$  market characteristics

# Model 1

- $N$  potential entrants
- Profit of each firm when  $n$  active =  $\Pi_m(n)$ 
  - $\Pi_m$  decreasing in  $n$
- Equilibrium:

$$\Pi_m(n_m) \geq 0 \text{ and } \Pi_m(n_m + 1) < 0$$

- Observe: market size, characteristics, & number of firms
- What can that tell us about competition?

## Motivating Model

- $n$  identical firms, constant marginal cost  $c$
- Linear aggregate demand

$$p = a - b \left( \overbrace{\sum_{i=1}^n q_i}^{\equiv Q} \right)$$

- Symmetric Cournot equilibrium
  - Quantities  $q_i^* = \frac{a-c}{b(n+1)}$
  - Profits  $\pi = \frac{(a-c)^2}{b(n+1)^2}$
- Fixed cost  $F$  determines number of firms

$$\frac{(a-c)^2}{b(n+1)^2} - F \geq 0 \text{ and } \frac{(a-c)^2}{b(n+2)^2} - F < 0$$

- How do parameters relate to market size?
- What happens with different models of firm conduct?

# Model 1

- Profit function:

$$\begin{aligned}\Pi_m(n) &= \underbrace{V_m(n)}_{\text{variable}} - \underbrace{F_m(n)}_{\text{fixed}} \\ &= S_m v_m(n) - F_m(n) \\ &= S_m (x_m^D \beta - \alpha(n)) - (x_m^C \gamma + \delta(n) + \epsilon_m)\end{aligned}$$

where

- $\alpha(1) \leq \alpha(2) \leq \dots \leq \alpha(N)$
- $\delta(1) \leq \delta(2) \leq \dots \leq \delta(N)$ 
  - Entry deterrence, firm heterogeneity, real estate prices
- Key difference between variable and fixed profits is that variable depend on  $S_m$ , fixed do not

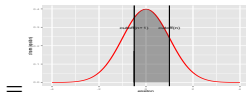
- Parameters  $\theta = (\beta, \gamma, \alpha, \delta)$
- MLE

$$\hat{\theta} = \arg \max_{\theta} \sum_{m=1}^M \log P(n_m | x_m, S_m; \theta)$$

- Assume  $\epsilon_m \sim N(0, 1)$ , independent of  $x_m, S_m$

$$P(n | x_m, S_m; \theta) = P(\Pi_m(n) \geq 0 > \Pi_m(n+1))$$

$$= P \left( \begin{array}{l} S_m x_m^D \beta - x_m^C \gamma - S_m \alpha(n) - \delta(n) \geq \epsilon \\ \epsilon > S_m x_m^D \beta - x_m^C \gamma - S_m \alpha(n+1) - \delta(n+1) \end{array} \right)$$



$$= \Phi \left( S_m x_m^D \beta - x_m^C \gamma - S_m \alpha(n) - \delta(n) \right) - \Phi \left( S_m x_m^D \beta - x_m^C \gamma - S_m \alpha(n+1) - \delta(n+1) \right)$$

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Questions

Examples

Methodology

Structural  
empirical  
models in IO

Economic Model

Econometric  
specification

Example: Bresnahan  
and Reiss (1991)

References

- 202 isolated local markets
  - Population 500-75,000
  - $\geq 20$  miles from nearest town of 1,000+
  - $\geq 100$  miles from city of 100,000+
- 16 industries: retail and professions, each estimated separately

# Results

- For most industries,  $\alpha(n)$  and  $\delta(n)$  increase with  $n$
- Define  $S(n) =$  minimal  $S$  such that  $n$  firms enter

$$S(n) = \frac{x_m^C \gamma + \delta(n)}{x_m^D \beta - \alpha(n)}$$

- Varies across industries
- $\frac{S(n)}{n} \approx$  constant for  $n \geq 5$ 
  - Contestable markets (Baumol, Panzar, and Willig, 1982) : an industry can be competitive even with few firms if there is easy entry

TABLE 5  
A. ENTRY THRESHOLD ESTIMATES

PROFESSION	ENTRY THRESHOLDS (000's)					PER FIRM ENTRY THRESHOLD RATIOS			
	$S_1$	$S_2$	$S_3$	$S_4$	$S_5$	$s_2/s_1$	$s_3/s_2$	$s_4/s_3$	$s_5/s_4$
Doctors	.88	3.49	5.78	7.72	9.14	1.98	1.10	1.00	.95
Dentists	.71	2.54	4.18	5.43	6.41	1.78	.79	.97	.94
Druggists	.53	2.12	5.04	7.67	9.39	1.99	1.58	1.14	.98
Plumbers	1.43	3.02	4.53	6.20	7.47	1.06	1.00	1.02	.96
Tire dealers	.49	1.78	3.41	4.74	6.10	1.81	1.28	1.04	1.03

B. LIKELIHOOD RATIO TESTS FOR THRESHOLD PROPORTIONALITY

Profession	Test for $s_4 = s_5$	Test for $s_3 = s_4 = s_5$	Test for $s_2 = s_3 = s_4 = s_5$	Test for $s_1 = s_2 = s_3 = s_4 = s_5$
Doctors	1.12 (1)	6.20 (3)	8.33 (4)	45.06* (6)
Dentists	1.59 (1)	12.30* (2)	19.13* (4)	36.67* (5)
Druggists	.43 (2)	7.13 (4)	65.28* (6)	113.92* (8)
Plumbers	1.99 (2)	4.01 (4)	12.07 (6)	15.62* (7)
Tire dealers	3.59 (2)	4.24 (3)	14.52* (5)	20.89* (7)

NOTE.—Estimates are based on the coefficient estimates in table 4. Numbers in parentheses in pt. B are degrees of freedom.

\* Significant at the 5 percent level.



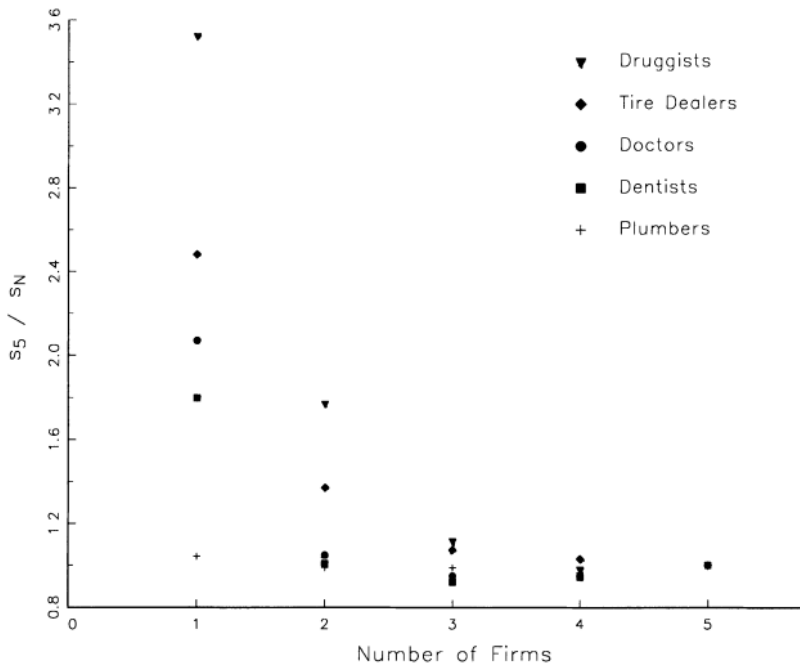


FIG. 4.—Industry ratios of  $s_5$  to  $s_N$  by  $N$

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