Introduction to empirical industrial organization

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References

- **Berry, Gaynor, and Scott Morton (2019)**
- Aguirregabiria (2019) chapter 1
- Reiss and Wolak (2007) through section 4
- Einav and Levin (2010)

Section 1

Questions

Industrial organization

Industrial organization is about the structure of industries in the economy and the behavior of firms and individuals in these industries

- Departures from perfect competition
  - Strategic behavior
  - Scale economies
  - Transaction costs
  - Information frictions
- Impact on firms' profits and consumers' welfare

General Approach

- Goal: model how profits and welfare are influenced by "exogenous" factors such as:
  - Demand
  - Technology
  - Institutional features and regulation
- Also interested in:
  - **Market structure**: number of firms and their respective market shares
  - **Market power**: ability of firms to earn extraordinary profits
- 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

Example 1

- These three examples come from Aguirregabiria (2012)
- **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

Example 2

- **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

Example 3

- **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, $\sum_{i=1}^{N} \text{share}_i^2$
  - Drawbacks:
    - Ignores industry heterogeneity
    - Does not identify causal effect
    - 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
    - Agents fail to exactly maximize their payoffs
  - 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.

Econometric specification 2

    - Reasons: (i) computational tractibility, (ii) limited data size, (iii) identification (often questionable)
    - E.g. utility CRRA, Cobb-Douglas production function, prodictivity 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: payoffs $= f$(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 $= \Pi_m(n)$
  - Π_m decreasing in n
- Equilibrium:

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

- Profit function:

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

where

- $\alpha(1) \leq \alpha(2) \leq \cdots \leq \alpha(N)$

Model 2

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

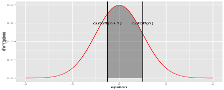
Estimation 1

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

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

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

$$\begin{aligned}
\mathrm{P}(n|x_m, S_m; \theta) =& \mathrm{P}\left(\Pi_m(n) \geq 0 > \Pi_m(n+1)\right) \\
=& \mathrm{P}\begin{pmatrix} S_m x_m^D \beta - x_m^C \gamma - S_m \alpha(n) - \delta(n) \geq \epsilon \\ \epsilon > S_m x_m^D \beta - x_m^C \gamma - S_m \alpha(n+1) - \delta(n+1) \end{pmatrix} \\
=&
\end{aligned}$$



$$\begin{aligned}
=& \Phi\left(S_m x_m^D \beta - x_m^C \gamma - S_m \alpha(n) - \delta(n)\right) - \\
& - \Phi\left(S_m x_m^D \beta - x_m^C \gamma - S_m \alpha(n+1) - \delta(n+1)\right)
\end{aligned}$$

Data

- 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) S_1	S_2	S_3	S_4	S_5	Per Firm Entry Threshold Ratios 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.

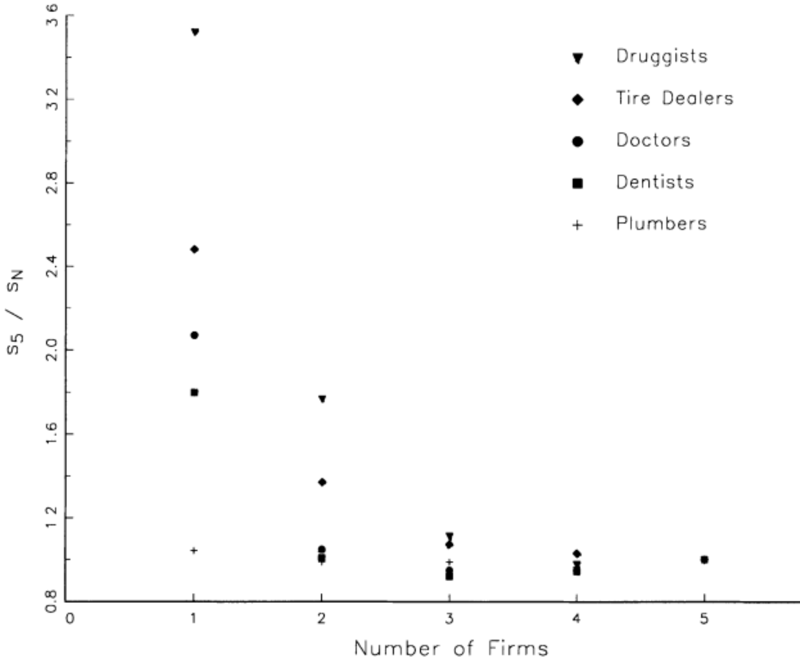


FIG. 4.—Industry ratios of s_5 to s_N by N

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