Entry and Exit 1
PhD Industrial Organization

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Motivation

- So far, we have studied models where the **market structure is fixed**.
  - Market structure: number of firms, types of products, firm size etc
  - Example of what we have implicitly assumed so far: demand estimation took characteristics of products as fixed, supply side: profit maximization given product characteristics

Motivation

- Now, we will take a step back and start to think about **endogenous market structure**.
  - Fundamental IO question: why exactly does market structure vary across industries?
  - Clear implications for policy:
  - Example 1: Effects of a merger
  - Example 2: Increasing costs due to environmental regulation
  - Example 3: Bailout of the truck manufacturing industry

Motivation

- We will start by looking at some simple models of firm entry and exit.
- Theoretical model as a starting point:
- **Stage 1**: Potential entrants decide whether to enter
- **Stage 2**: Firms compete given entry
- Later on in the course we will study dynamic games which contain strategic interactions between firms, investment, entry, and exit, over time.

Motivation

- **Today:** we will look at some earlier work attempting to estimate entry models.
- As we will see, although these paper are creative, influential, and important, they often require some strong assumptions in order to take the model to data.
- Next time we will see a new strand of literature that resolves a key assumption of these papers.
  - Key assumption: uniqueness of equilibrium

Plan

1. Bresnahan and Reiss (1991)
2. Mazzeo (2002)
3. Seim (2006)

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1. **Bresnahan and Reiss (1991)**
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Bresnahan and Reiss (1991): Research Questions

- 1. How do profits change with the number of firms?
- 2. How many firms need to enter before an oligopoly market becomes competitive?

Bresnahan and Reiss (1991): Data

- Isolated markets M (202 markets)
  - Isolated since it is easier to define a 'market' and 'entry into a market'. I.e. these markets are independent in terms of demand, competition, etc.
  - Pre-internet, they got this data through the phonebook and also by driving (or maybe getting their RA to drive) around small towns in Western USA (!)
- Look at retail/professional services e.g. doctors, dentists, plumbers
- For each market m: observe active firms n_m, market size s_m, and some exogenous market characteristics that may affect demand/costs x_m

Bresnahan and Reiss (1991): Model

- Homogeneous firms. N potential entrants.
- Equilibrium number of firms n_m satisfies:

$$\begin{aligned} \Pi_m(n_m) &\geq 0 \\ \Pi_m(n_m + 1) &< 0 \end{aligned}$$

- That is, each firm is playing a best respose to the other firms: all active firms stay in the market, all inactive firms stay out.

Bresnahan and Reiss (1991): Model

- Parameterize profit as follows:

$$\Pi_m(n_m) = V_m(n) - F_m(n)$$

- Where $V_m(n)$ is variable profit:

$$V_m(n) = s_m v_m(n) = s_m(x_m^D \beta - \alpha(n))$$

- s_m: market size
- $v_m(n)$: variable profit per-capita
- x_m^D: vector of market characteristics that may affect demand (e.g. per-capita income)
- β: parameter vector
- $\alpha(n)$: parameter that captures degree of competition (strictly increasing in n).

Bresnahan and Reiss (1991): Model

- Here, $F_m(n)$ is fixed cost:

$$F_m(n) = x_m^C \gamma + \delta(n) + \epsilon_m$$

- x_m^C: vector of observable market characteristics that could affect fixed costs (e.g. rental price)

- ϵ_m: unobservable (to the econometrician) market characteristic

- $\delta(1), ..., \delta(N)$: parameters (note: a bit odd that fixed cost depends on n)

Bresnahan and Reiss (1991): Model

- Since $\alpha(n)$ and $\delta(n)$ increase with n, can show that profit decreases with n.
- Can also show that the model has a unique equilibrium n_m (given exogenous variables) due to strictly decreasing $\Pi_m(n)$.

Bresnahan and Reiss (1991): Estimation

- Assume that unobserved component of entry costs ϵ_m is independent of market shares and market characteristics, and is distributed $N(0, \sigma)$.
  - Also, normalize scale $\sigma = 1$.

- Rearrange equilibrium number of firms condition (i.e $\Pi_m(n_m) \geq 0$ and $\Pi_m(n_m + 1) < 0$) in terms of thresholds for ϵ_m:

$$T_m(n+1) < \epsilon_m \leq T_m(n)$$

- Where:

$$T_m(n) = s_m x_m^D \beta - x_m^C \gamma - \alpha(n) s_m - \delta(n)$$

Bresnahan and Reiss (1991): Estimation

- Estimate model using an <u>ordered probit</u>:

$$Pr(n_m = n | s_m, x_m) = \Phi(T_m(n)) - \Phi(T_m(n+1))$$

- Can estimate with maximum likelihood.

Bresnahan and Reiss (1991): Results

- Get market size entry thresholds.

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

- Note that these don't depend in the normalization $\sigma = 1$.

- These are the minimum market size to sustain n firms in the market.

- Compute entry threshold ratios e.g. $S_2/S_1 = \frac{S(2)}{2} / \frac{S(1)}{1}$
  - E.g. as number of firms increases by 1, does market double (ratio $= 1$) or need to more than double (ratio > 1)?

Bresnahan and Reiss (1991)

Table 1
Per Firm Entry Thresholds from Bresnahan and Reiss (1991b), Table 5

Profession	S_2/S_1	S_3/S_2	S_4/S_3	S_5/S_4
Doctors	1.98	1.10	1.00	0.95
Dentists	1.78	0.79	0.97	0.94
Druggists	1.99	1.58	1.14	0.98
Plumbers	1.06	1.00	1.02	0.96
Tire Dealers	1.81	1.28	1.04	1.03

Bresnahan and Reiss (1991): Main Findings

- Monopoly to duopoly (for most of the industries studied) requires more than double the market size
  - Their data do not allow them to say why.
  - One explanation: barriers to entry change with N (cost story).
  - Another explanation: markups change with N (e.g. consistent with a Cournot model).
- When number of firms > 4: double market size implies double the number of firms. (Consistent with 'contestable market hypothesis': if barriers to entry are low then market behaves in a competitive way.)

Plan

1. Bresnahan and Reiss (1991)
2. **Mazzeo (2002)**
3. Seim (2006)

Mazzeo (2002)

- **Question:**
- What drives the product-type decisions of firms in oligopoly markets?
- **Approach**
- Similar assumptions in the model to Bresnahan and Reiss (1991)
  - Complete information
  - No dynamics, no spatial differentiation
- Endogenizes **firm product choice**
- Data from the motel industry (use local markets along US highway exits)

Mazzeo (2002): Model

- Different types of hotels (H: high-quality, E: economy hotel)
- Hotels choose their type and also whether to enter
- Profit of an active hotel of type $T \in \{E, H\}$ is:

$$\pi_T(n_E, n_H) = sV_T(x, n_E, n_H) - EC_T(x) - \epsilon_T$$

- Here, n_E and n_H represent the number of active hotels of low and high quality in the market.
- V_T: variable profit (per-capita)
- $EC_T(x) + \epsilon_T$: entry cost for type T hotels (where ϵ_T is unobservable to the researcher).

Mazzeo (2002): Model

- Paper uses alternative two solution concepts:
- 1. Stackelberg
  - Specifically, employs the **equilibrium selection rule** that firms enter sequentially with high-quality firms moving first
- 2. A 'two-stage game': firms choose whether to enter and their type
  - We will now talk more about this alternative

Mazzeo (2002): Model

- In the **first-stage** the total number of active hotels $n = n_E + n_H$ is determined similarly to the Bresnahan-Reiss model.

- That is, hotels continue to enter the market so long as there is some configuration (n_E, n_H) where both low-quality and high-quality hotels make positive profits.

$$\Pi(n) = \max_{n_E, n_H : n_E + n_H = n} \min[\pi_E(n_E, n_H), \pi_H(n_E, n_H)]$$

- Then, the equilibrium number of hotels in the first-stage is n^* where $\Pi(n^*) \geq 0$ and $\Pi(n^* + 1) < 0$)

- If π_E and π_H are strictly decreasing in the number of active firms then $\Pi(n)$ is also strictly decreasing $\rightarrow$ n^* is **unique**.

Mazzeo (2002): Model

- In the **second-stage** active hotels simultaneously choose their type or quality level.
- Here, equilibrium is a pair (n_E^*, n_H^*) such that every firm chooses the type that maximizes its profit given the choices of the other firms.
    - So, low-quality firms are not better off switching to high-quality etc...

$$\pi_E(n_E^*, n_H^*) \geq \pi_H(n_E^* - 1, n_H^* + 1)$$
$$\pi_H(n_E^*, n_H^*) \geq \pi_E(n_E^* + 1, n_E^* - 1)$$

- Mazzeo shows that the equilibrium pair given in the above equations is also unique.

Mazzeo (2002): Estimation

- Using the equilibrium conditions, possible to obtain a closed-form expression for the region of unobservables (ϵ_E, ϵ_H) that generate a particular value of (n_E^*, n_H^*).

- Let $R_E(n_E, n_H; s, x)$ be the region associated with n_E, n_H and F be the CDF of the unobservable variables. Then:

$$Pr(n_E^* = n_E, n_H^* = n_H | s, x) = \int 1\{(\epsilon_E, \epsilon_H) \in R_E(n_E, n_H; s, x)\} dF(\epsilon_E, \epsilon_H)$$

- Can the process similarly to Bresnahan and Reiss (1991): parameterize the payoff function and estimate using observed number of firms in each market using maximum likelihood.

Mazzeo (2002): Results (not time to go into these in detail)

- Overall, finds evidence that firms have strong incentives to offer different products to their competitors.
- Specifically, "the negative effect that a competitor has on firm payoffs is up to twice as large if that competitor is the same product type".

Plan

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Seim 2006

- **Question:** How important is spatial differentiation in explaining market power?
- Example: think of two grocery stores located in a city.
  - Differences in demand between locations
  - Positioning compared to competitors
  - Other factors like rent
- Importantly: relaxes the ‘isolated market’ assumption.
- Application: video-rental industry

Seim 2006

FIGURE 1

IMPACT ON PROFITS OF COMPETITORS' LOCATIONS: ILLUSTRATION

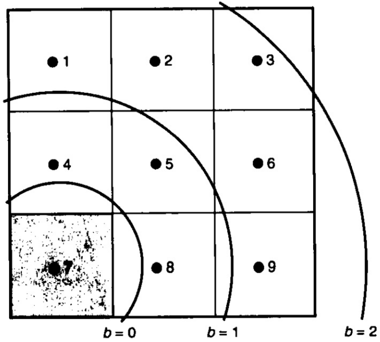

Figure: New firm locates in position 7.

Seim 2006: Very Brief Overview

- N potential entrants choose whether to enter a market. If enter they choose their location.
- Challenges:
  - Computation complexity (many choices and configurations of firms)
  - Multiple equilibria
- Key assumption: rivals have (some) private information about profitability. Hence, when each firm enters, they do not know for sure where their rivals will enter.
- Then, the choice to enter is made on the expected value of profits taken over the probability that other firms will enter other locations.
- She shows in the paper this makes it easier to compute an equilibrium. Uniqueness is tricky (she has some simulations for simple cases).