ECON-L1350 - Empirical Industrial Organization PhD II: Topic

Static Entry Models: Lecture 1

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Why (static) entry?

- It is widely thought that (potential) entry is one of the main competitive forces.
- Entry and post-entry competition linked $\rightarrow$ insights into the latter from studying the former.
- Static entry models are a first step towards understanding endogenous product choice decisions (e.g. location).
- Static entry models a first step towards dynamics.
- Modeling entry may be key to understanding selection problems in IO (e.g. productivity).
- It is known that not considering entry (endogenous market strucure) may lead to wrong counterfactual results (e.g. Wollmann, 2018.)

Objectives of these lectures

By the end of these lectures, you

- know why static entry models are used,
- understand what decisions are important regarding the data and observation units,
- understand the trade-offs related to making different informational assumptions,
- understand how the model parameters are identified and
- know how to estimate (some of) the models.

How we proceed

1. Data requirements / issues.
2. Identification in a monopoly entry model.
3. A little detour to theory.
4. Oligopoly entry games with perfect information: The root of the problem.
5. Potential solutions and their implementation:
    1. Bresnahan and Reiss (1991): circumvent the problem.
    2. S. T. Berry (1992), Toivanen and Waterson (2005): impose order of entry.
    3. Tamer (2003): use incomplete model.
    4. Seim (2006): change assumption on information.

An aside

- An author that is nowadays badly overlooked but hugely important is John Sutton:
- Sutton, J. (1991). *Sunk costs and market structure*. MIT Press.
- Sutton, J. (1998). *Technology and market structure*. MIT Press.
- These books are well worth reading. If they exceed your attention span, there are very good review articles such as Bresnahan (1992) and Scherer (2000).

Data requirements

Data requirements / issues

- To model entry into a market, one needs to define "the market".
- Examples:
  - isolated US towns (e.g. tyre sellers, plumbers, dentists) (Bresnahan and Reiss, 1991),
  - city-pairs (airlines), e.g. S. T. Berry, 1992,
  - fast food in UK towns (Toivanen and Waterson, 2005).
- By defining the market the researcher defines the observation unit.

Data requirements / issues

- Are the (geographic, ..) markets independent?
- Does the researcher observe entry (dynamic) or market structure (static)?
- Does the researcher observe only presence, or also choices conditional on being in the market?
- Does the researcher know the set of potential entrants?
- Is entry $0/1$, or can a firm enter with multiple outlets / market?

Monopoly entry models

Minimal but fundamental economics

- The following assumptions are shared by essentially all structural models of entry:
  1. Firms that enter make non-negative profits.
  2. Non-entering firms do not want to enter as they would make negative profits.
- All empirical work relies on revealed preference.

Monopoly entry model

- A large part of the static entry literature considers models where only presence in the market is observed, not choices made conditional on being in the market.
- Important to consider what can be learned with only such data.
- Consider a cross-section of markets, each with one potential entrant.
- Profits are given by

$$\pi(x_i, F_i) = v(x_i) - F_i$$

- v is the deterministic part of profits as a function of profit-shifters x.
- F is the random component of profits, assumed to enter linearly.
- The primitives of the model are v and the distribution (cdf) of F, denoted Φ.

Monopoly entry model

- Entry condition is now

$$F_i \leq v(x_i)$$

- We can measure $p(x)$ = probability of entry from the data.
- Clearly, we can multiply both sides of the inequality by a constant without altering it.
- $\Rightarrow$ we need a normalization.

Matzkin (1992) identification result (see also S. Berry and Tamer, 2006)

Result 1: In the above model, if the function $v(x)$ *is homogenous of degree 1 and if there exists an* x_0 *such that* $v_1(x_0) = 0$*, then the functions* $v(.)$ *and* $\Phi(.)$ *are identified.*

- There are economic models that satisfy these assumptions.
- Think of a market where demand is proportional to population and *mc* is constant.

Matzkin (1992) identification result

- We can then (because the FOC does not depend on population) rewrite the model as

$$\pi(x_i, F_i) = z_i v(x_i) - F_i$$

- z_i = population.
- $v(x_i)$ = per capita profit.
- Let's normalize $v(x_0) = 1$ for some arbitrary value x_0.

Matzkin (1992) identification result

- This means that

$$
\begin{aligned}
p(z, x_0) &= \Pr(F < zv(x_0)) \\
&= \Pr(F < z) \\
&= \Phi(z)
\end{aligned}
$$

- $p(.)$ = observed entry probability in markets characterized by x_0.

Data on market outcomes

- Imagine you had data on M potential monopoly markets of a homogenous good and you observed
  1. whether or not there was entry and
  2. conditional on entry, price and quantity.
- Imagine further that demand and marginal cost shocks uncorrelated with shocks to entry costs.
- How would price and quantity data be helpful in modeling entry?

Knowing variable profits

- If you had price and quantity data, you could estimate demand and supply conditional on entry under teh above assumptions.
- Let's denote the profits conditional on entry with $\pi(x)$.
- Then you can back out the distribution of F because

$$\Pr(entry) = \Phi(\pi(x)).$$

Detour to theory

Theoretical basic setup

- How to endogenize entry?
- Workhorse model of the static entry literature: 2-stage games.
  1. Potential entrants choose whether or not to enter, those entering pay a fixed entry cost $K > 0$.
  2. Firms that actually entered play the stage game, e.g., choose prices or quantities.
  3. Backward induction, SPNE.
  4. Important paper: Mankiw, N. G. & Whinston, M. D. (1986). Free entry and social inefficiency. *The RAND Journal of Economics*, *17*(1), 48–58.
- Importance of post-entry competition: Compare equilibrium number of firms in constant *mc* homogenous goods Cournot to Bertrand.

Oligopoly entry models

2-firm example

- Following e.g. Tamer (2003), let's specify the following static full information entry game:

Table: 1

Discrete game with stochastic payoff

	$y_2 = 0$	$y_2 = 1$
$y_1 = 0$	$0, 0$	$0, x_2\beta_2 + u_2$
$y_1 = 1$	$x_1\beta_1 + u_1, 0$	$x_1\beta_1 + \delta_1 + u_1, x_2\beta_2 + \delta_1 u_2$

- Note what full information means in this context.
- x_j = firm-specific observable affecting profits.
- u_j = firm-specific unobservable ("shock") affecting profits.
- β_j, δ_j: parameters to be estimated.
- Let's assume $\beta_j > 0$, $\delta_j < 0$.

2-firm example

- This maps directly into the following econometric model:

$$
\begin{aligned}
y_1^* =& x_1\beta_1 + y_2\delta_1 + u_1 \\
y_2^* =& x_2\beta_2 + y_1\delta_2 + u_2
\end{aligned}
$$

$$
y_j = \begin{cases} 1 \text{ if } y_j^* \geq 0 & \text{for } j = 1, 2 \\ 0 \text{ otherwise} \end{cases} \tag{1}
$$

Coherent and complete econometric models

- Problem: multiple equilibria for a set of (u_1, u_2).
- $\rightarrow$ adding up probabilities of different outcomes sums up to > 1.
- **Coherency:** A model is coherent if it admits a *"well-defined reduced form"*.
- One can write a well-defined likelihood function for a coherent model.
- One can achieve coherency through theoretical and/or statistical assumptions.
- A **complete** model *"asserts that a random variable y is a function of a random pair (x, u), where x is observable and u is not"*.
- **Incompleteness:** the relationship between y and (x, u) is a correspondence, not a function.
- However, incomplete models (may) contain information!

How to proceed?

Potential solutions and their implementation:

1. Bresnahan and Reiss (1991): circumvent the problem by modeling the number of firms, not the identity of firms.
2. S. T. Berry (1992), Toivanen and Waterson (2005): impose order of entry to get a complete model (=unique SPNE).
3. Tamer (2003): use incomplete but coherent model.
4. Seim (2006): change assumption on information (does not necessarily guarantee uniqueness).

The Bresnahan-Reiss model

The Bresnahan-Reiss model

- Imagine data on a cross-section of markets where you observe

1. the number of (symmetric) firms in each market and
2. market characteristics (population, variables affecting per capita profits).

- Cost: symmetry throughout (though see Schaumans and Verboven, 2015).

The Bresnahan-Reiss model

- Suppose fixed cost F are identical across firms and i.i.d. over markets with pdf $\Phi(.)$.
- Further assume a variable profit function $z_m v(y_m, x_m)$ for market m where
  1. $y_m = \#$ firms
  2. $x_m =$ (vector) of observable shifters of profits / customers.
  3. $z_m =$ market size (=#customers)
- Also assume that $v(N, x_m) > v(N+1, x_m)$ where $N \geq 0$ is the number of firms.

The Bresnahan-Reiss model

- If there are y_m firms in market m, then profits are given by

$$\pi(y_m, x_m, F_m) = z_m v(y_m, x_m) - F_m$$

- The equilibrium number of firms is N:

$$z_m v(N, x_m) - F_m \geq 0$$
$$z_m v(N+1, x_m) - F_m < 0$$

- Then the probability of observing y firms is:

$$\Pr(y = 0|x) = 1 - \Phi(zv(1, x))$$
$$\Pr(y = 1|x) = \Phi(zv(1, x)) - \Phi(zv(2, x))$$
$$\Pr(y = 2|x) = \Phi(zv(2, x)) - \Phi(zv(3, x))$$
$$\ldots$$

The Bresnahan-Reiss model

- What can we learn?
- Intuition: Imagine that monopoly entry requires $z = 2000$.
- Question: what z would induce a second entrant?
- Assumption 1: Bertrand competition.
- Assumption 2: full collusion.

The Bresnahan-Reiss model

- BR assume the following functional forms:

$$\Pi_N = S(Y,)V_N(Z, W, \alpha, \beta) - F_N(W, \gamma) + \epsilon$$

$$S(Y, \lambda) = \textit{town pop} + \lambda_1 \textit{nearby pop} + \lambda_2 \textit{pos growth}$$
$$+ \lambda_3 \textit{neg pop} + \lambda_4 \# \textit{ comm}$$

$$V_N = \alpha_1 + X\beta - \sum_{n=2}^{N} \alpha_n$$

$$F_N = \gamma_1 + \gamma_L W_L + \sum_{n=2}^{N} \gamma_n$$

- These yield (estimates) of "entry tresholds"

$$S_N = \frac{F_n}{V_N}$$

- These allow BR to calculate ratios of entry tresholds S_{N+1}/S_N.

The Bresnahan-Reiss model

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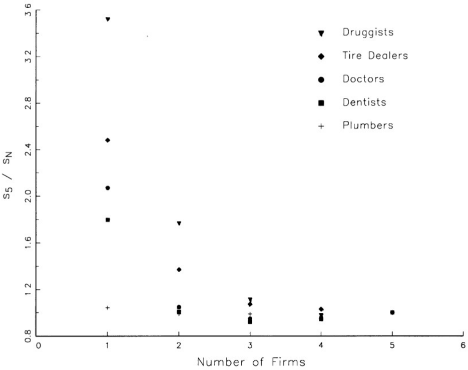

FIG. 4.—Industry ratios of s_5 to s_N by N

Figure: 5 (Bresnahan and Reiss, 1991)

The Bresnahan-Reiss model

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

Figure: Bresnahan and Reiss / Table 5 (from S. Berry and Reiss, 2007).

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