Entry and Exit: Sutton model*

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1 Sutton Model

- Goal is to understand structure of industry, how many firms, how big. What are the basic economic forces we want to work in here.
- Start with a simple Cournot model, symmetric cost structure and no scale economies.
- Look at the question: how does market structure change when S (market size) increases? Note, besides book mentioned in the syllabus, has a chapter in the *Handbook of IO* volume 3.
- As an aside, Sutton started career as s theorist. Finds industry case studies unappealing, wants to be a scientist, look for general patterns. Respects what old-time IO guys like Joe Bain from the 1960s were up to as far as ambition, just thinks they were on the wrong track.
- Sutton looking for robust predictions. Thinks he has one. Contrasts

  1. exogenous fixed costs case
  2. endogenous fixed costs case

*These notes rely heavily on Thomas Holmes's lecture notes

First, what do we mean by robust predictions? Predictions that hold across a variety of game-theoretic models

- Holds regardless of Nash in prices or Nash in quantities (Bertrand or Cournot)
- Holds regardless of simultaneous entry or sequential entry
- Holds regardless of modeling of firm variety (Dixit-Stiglitz or Hotelling)
- etc.

Empirically can be hard to distinguish these different models, especially looking at cross-section of industries across countries.

This approach is in contrast to the industry-by-industry approach usually taken by structural economists.

1.1 Exogenous fixed cost case

- Let S be the size of market (number of consumers) Assume each consumer has unit income, get industry demand (per consumer) equals (from the budget constraint)

$$p \cdot X_D = S \cdot 1 \tag{1}$$

$$X_D = S/p \tag{2}$$

unless $p \geq p_0$ (and then go to outside good). Suppose marginal cost c and entry cost is $\epsilon > 0$.

- Consider a two stage game. In the first stage firms decide whether or not to enter. In the second stage they play Cournot. Start with second stage, assume that N firms have entered.

- Work out Cournot: Take as given that $(N-1)$ firms produce x, look at the problem of firm 1, where the firm is maximizing profit per consumer.

$$\max_{x_1}\{p(\sum_{j=1}^{N} x_j)x_1 - cx_1\} \tag{3}$$

Plugging in $p = S/X_D$

$$(\frac{S}{\sum_j x_j} - c)x_1 \tag{4}$$

- and differentiating gives us FOC

$$-\frac{S}{(\sum_j x_j)^2}x_1 + \frac{S}{\sum_j x_j} - c = 0 \tag{5}$$

- summing over all N firms and letting $X = \sum_j x_j$

$$\sum_i \big[-\frac{S}{(\sum_j x_j)^2} x_i + \frac{S}{\sum_j x_j} - c\big] = 0$$

$$-\frac{S}{(\sum_j x_j)^2} \sum_i x_i + N\big[\frac{S}{X} - c\big] = 0$$

$$-\frac{S}{X^2} X + N\big[\frac{S}{X} - c\big] = 0$$

$$-\frac{S}{X}(1 + N) = Nc$$

$$\frac{S}{c}\frac{N-1}{N} = X$$

- using symmetry and $p = S/X$ we get

$$x_i = \frac{S}{c}\frac{N-1}{N^2}, \quad p = c\big(1 + \frac{1}{N-1}\big) \tag{6}$$

- plugging back into the firm's profit function, we get equilibrium profits are

$$(p - c)x_i \tag{7}$$

$$\big[c\big(1 + \frac{1}{N-1}\big) - c\big]\frac{S}{c}\frac{N-1}{N^2} \tag{8}$$

- So Cournot profit per firm is

$$\text{Cournot Profit} = \frac{S}{N^2} \tag{9}$$

- Go back to first stage (entry decision). Assume there are lots of potential entrants and that there is free entry – which implies there is a zero profit condition:

$$\epsilon = \text{Cournot Profit} = \frac{S}{N^2} \tag{10}$$

  which reduces to

$$N = \sqrt{\frac{S}{\epsilon}} \tag{11}$$

$$C_1 = \frac{1}{N} = 1/\sqrt{\frac{S}{\epsilon}} \tag{12}$$

where C_k is the k-firm concentration ratio (share of output accounted for by the k largest firms).

- Key point: C_1 falls and goes to zero as S gets large.
- How robust is this prediction? ($N \to \infty$ as $S \to \infty$?)
- Suppose we change the model so firms collude with entry. Then $p = p_0$, where p_0 is the outside good price, and so the monopoly price. Industry profit per consumer is (use fact that $p_0 x =$ unit income) and so

$$(p_0 - c)x = (p_0 - c)\frac{1}{p_0} \tag{13}$$

- and so profit per firm is

$$\text{Collusive profit} = (p_0 - c)\frac{1}{p_0}\frac{S}{N}. \tag{14}$$

Entry then solves:

$$\epsilon = (p_0 - c)\frac{1}{p_0}\frac{S}{N}. \tag{15}$$

- Get the same prediction that market share goes to zero as S gets large. Or, that $N \to \infty$ as $S \to \infty$.
- Show figure 2.2 in book on page 34

1.2 Endogenous fixed cost case

- let utility be given

$$U = (ux)^\delta z^{1-\delta} \tag{16}$$

  where u is perceived quality. Assume there is a set of qualities (u_1, u_2, u_3). wlog assume $u_i \geq u_{i+1}$.

- Consumers maximize u_i/p_i. (pick best deal.)

- Firms compete in output in a Cournot fashion each with marginal cost c. Perceived quality is chosen in an earlier stage (related to fixed cost), and there is constant marginal cost c.

- Can derive the following profit function

$$\pi_i = \left\{1 - \frac{N-1}{u_i} \frac{1}{\sum(1/u_j)}\right\}^2 S \tag{17}$$

  where there is a quality threshold $\hat{u}$ and N firms with $u_i > \hat{u}$ survive. The rest produce no output.

- An aside: can recast this as follows. W.L.O.G. suppose $u_1 \geq u_i$. Problem is isomorphic to one where set marginal cost $c_1 = c, c_i = c \cdot u_1/u_i, \ldots,$. So now asymmetric cost Cournot oligopoly with homogeneous products. Easy to see if have a Cournot oligopoly with $(c_1, c_2, c_3, \ldots, c_N)$ and all in, easy to see what the marginal guy would be.

- Now lets consider the earlier rounds.

  1. First stage: entry decisions are made and then quality picks are chosen. Fixed cost is

$$F(u) = F_0 u^\beta \quad \text{for } u \geq 1. \tag{18}$$

     where $F_0 > 0$.

  2. Second stage: Cournot game described above

- think of u as advertising or R&D expenses to get u above the $\hat{u}$.
- If S is small, get vanilla Cournot where all firms choose the minimal level of quality, $u = 1$.
- But once S gets big, the returns to incurring fixed outlays on quality improvement rise, and the level of u rises thereafter with S.
- Lets see this in a general structure.
- Profit is $\Pi(u_i|u_{-i}) - F(u_i)$, for some location choice u_i for entrant i.
- Assume that $\Pi(u_0|\emptyset) > F(u_0)$, some u_0 and so someone always wants to enter.
- An N tuple $\mathbf{u}$ is an equilibrium configuration if
  1. Viability:
  $$\Pi(u_i|u_{-i}) - F(u_i) \geq 0 \text{ for all } i \tag{19}$$
  2. Stability: there is no u_{N+1} such that
  $$\Pi(u_{N+1}|\mathbf{u}) - F(u_{N+1}) \geq 0 \tag{20}$$
  or further entry is not profitable.
- Lets use these equilibrium conditions to consider what happens to market share as S goes to infinity.

Escalation Mechanism for Endogenous Fixed Cost

- context of the exercise — determining if some types of configurations of $\mathbf{u}$ are unstable against entry by a "high-spending" entrant. Consider the example for an entrant comes in who spends enough in fixed costs to get k times greater quality than highest current level of $\mathbf{u}$.
- Define $\hat{u}(\mathbf{u}) = \max_i u_i$

- Firm profits $\Pi = S\pi(u_i|u_{-i})$ defining profits per customer, π
- $y(\mathbf{u})$ is industry output per consumer given $\mathbf{u}$, so total output is $Y(\mathbf{u}) = Sy(\mathbf{u})$.
- Define for a given k,

$$a(k) = \inf_{\mathbf{u}}(\pi(k\hat{u}|\mathbf{u}))/y(\mathbf{u}) \tag{21}$$

The context of a is what is the minimum ratio of the high-spending entrant's profit to current industry sales that can be attained independently of the current configuration of $\mathbf{u}$ and the size of the market? So looking at inf and considering things on a per-consumer basis.

Non-convergence theorem: given any pair $(k, a(k))$, a necessary condition for any configuation to be an equilibrium configuration is that a firm offering the highest level of quality has a share of industry sales revenue *exceeding*

$$\frac{a(k)}{k^\beta} \tag{22}$$

Proof: Consider the "high-spending" entrant's net profit is at least (b/c of inf)

$$a(k)Sy(\mathbf{u}) - F(k\hat{u}) = a(k)Sy(\mathbf{u}) - k^\beta F(\hat{u}) \tag{23}$$

- Stability implies that this entrant's profitability must be non-positive, and so

$$F(\hat{u}) \geq \frac{a(k)}{k^\beta} Sy(\mathbf{u}) \tag{24}$$

- and viability implies that firm $\hat{u}$ earns non-negative profits

$$S\hat{y} \geq F(\hat{u}) \tag{25}$$

where $\hat{y}$ is the sales revenue earned by firm $\hat{u}$ per consumer.

- Putting these together and simplifying

$$\frac{S\hat{y}}{Sy(\mathbf{u})} \geq \frac{a(k)}{k^\beta} \tag{26}$$

- Intuition: if this industry consists of a large number of small firms, then the viability condition implies that each firm's spending on R&D (or advertising) is small relative to the industry sales revenue. In this setting, the returns to a high-spending entrant may be large, so that the stability condition is violated. Hence a configuration that is "too low" cannot be an equilibrium configuration.
- Sutton shows that the above theorem implies that the share of industry sales enjoyed by the largest firm is bounded below.
- look at figures