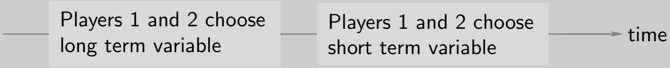
OLIGOPOLY MODELS AT WORK

Overview

- Context: You are an industry analyst and must predict impact of tax rate on price and market shares. Ditto for exchange rate devaluation, cost-reducing innovation, quality improvement, merger, etc.
- Concepts: comparative statics, calibration, counterfactual
- Economic principle: models can help qualitatively as well as quantitatively — but you should know how to find the right model

Long term and short term

- If players make more than one strategic choice, how to model the sequence of moves
- Players make short term moves *given* their long term choices
- Even if short term moves are made simultaneously, the above "given" suggests a sequence:



- The choice between Cournot and Bertrand models depends largely on determining what is long term, what is short term

Choosing oligopoly model

- Homogeneous product industry where firms set prices. Which model is better: Bertrand or Cournot?
- It depends!
  - Capacity constraints important: Cournot
  - Capacity constraints not important: Bertrand
- More generally, the easier (the more difficult) it is to adjust capacity levels, the better an approximation the Bertrand (the Cournot) model provides
  - Bertrand: price is the long-run choice
  - Cournot: output is the long-run choice

Examples

- Consider the following products:
  - banking
  - cars
  - cement
  - computers
  - insurance
  - software
  - steel
  - wheat
- Indicate which model is more appropriate: Bertrand or Cournot

Comparative statics / counterfactual

- What is the impact of event x on industry y?
- Comparative statics (or counterfactual):
  - Compute initial equilibrium
  - Recompute equilibrium considering effect of x on model parameters
  - Compare the two equilibria
- In what follows, will consider the following events x:
  - Increase in input costs
  - Exchange rate devaluation
  - New technology adoption

Input costs and output price

- Market: flights between NY and London
- Firms: AA and BA
- Marginal cost (same for both): labor (50%), fuel (50%); initially, marginal cost is $300 per passenger.
- Oil price up by 80%
- What is the effect of oil price hike on fares?

Input costs and output price

- Cournot duopoly with market demand $p = a - b\,Q$
- Equilibrium output per firm and total output:

$$\widehat{q} = \frac{a-c}{3\,b} \qquad \widehat{Q} = 2\,\frac{a-c}{3\,b}$$

- Equilibrium price:

$$\widehat{p} = a - b\,\widehat{Q} = a - b\,2\,\frac{a-c}{3\,b} = \frac{a+2\,c}{3}$$

- Therefore

$$\frac{d\,\widehat{p}}{d\,c} = \frac{2}{3}$$

- Economics lingo: the pass-through rate is 66%

Input costs and output price

- Oil price increase of 80%; fuel is 50% cost; initial cost is \$300
- Increase in marginal cost: $50\% \times 80\% \times \$300 = \$120$
- Price increase: $\frac{2}{3}\,120 = \$80$

Exchange rate fluctuations

- Two microprocessor manufacturers, one in Japan, one in US
- All customers in US
- Initially, $e = 100$ (exchange rate Y/\$), $p = 24$
  Moreover, $c_1 =$ Y1200, $c_2 = \$12$.
- Question: what is the impact of a 50% devaluation of the Yen (that is, $e = 150$) on the Japanese firm's market share?

Asymmetric Cournot duopoly

- Best response mappings:

$$q_1^*(q_2) = \frac{a - c_1}{2\,b} - \frac{q_2}{2}$$
$$q_2^*(q_1) = \frac{a - c_2}{2\,b} - \frac{q_1}{2}$$

- Solving system $q_i = q_i^*(q_j)$

$$\widehat{q}_1 = \frac{a - 2\,c_1 + c_2}{3\,b}$$
$$\widehat{q}_2 = \frac{a - 2\,c_2 + c_1}{3\,b}$$

Asymmetric Cournot duopoly

- Firm 1's market share:

$$s_1 = \frac{q_1}{q_1 + q_2} = \frac{a - 2\,c_1 + c_2}{2\,a - c_1 - c_2}$$

- In order to say more, need to know value of parameter a

Calibration

- At initial equilibrium, $p = 24$
- In equilibrium (when $c_1 = c_2 = c$)

$$p = \frac{a + 2\,c}{3}$$

- Solving with respect to a

$$a = 3\,p - 2\,c = 3 \times 24 - 2 \times 12 = 48$$

- Calibration: use observable data to determine values of unknown model parameters

Exchange rate fluctuations

- Upon devaluation, $c_1 = 12/1.5 = 8$
- Hence

$$\widehat{s}_1 = \frac{48 - 2 \times 8 + 12}{2 \times 48 - 8 - 12} \approx 58\%$$

- So, a 50% devaluation of the Yen increases the Japanese firm's market share to 58% from an initial 50%

New technology and profits

- Chemical industry duopoly
- Firm 1: old technology, $c_1 = \$15$
- Firm 2: new technology, $c_2 = \$12$
- Current equilibrium price: $p = \$20$, $Q = 13$
- Question: How much would Firm 1 be willing to pay for the modern technology?
- Answer: difference between equilibrium profits with new and with old technology (comparative statics)

Calibration

- We have seen before that

$$\widehat{Q} = \widehat{q}_1 + \widehat{q}_2 = \frac{2\,a - c_1 - c_2}{3\,b}$$
$$\widehat{p} = a - b\,\widehat{Q} = \frac{a + c_1 + c_2}{3}$$

- Solving with respect to a, b

$$a = 3\,\widehat{p} - c_1 - c_2 = 3 \times 20 - 15 - 12 = 33$$

$$b = \frac{2\,a - c_1 - c_2}{3\,\widehat{Q}} = (2 \times 33 - 15 - 12)/(3 \times 13) = 1$$

New technology and profits

- We have seen before that

$$\widehat{\pi}_i = \frac{1}{b}\left(\frac{a + c_j - 2\,c_i}{3}\right)^2$$

- Therefore

$$\widehat{\pi}_1 = \left(\frac{33 + 12 - 2 \times 15}{3}\right)^2 = \left(\frac{15}{3}\right)^2 = 25$$

$$\widehat{\widehat{\pi}}_1 = \left(\frac{33 + 12 - 2 \times 12}{3}\right)^2 = \left(\frac{21}{3}\right)^2 = 49$$

$$\widehat{\widehat{\pi}}_1 - \widehat{\pi}_1 = 24$$

Naive (non-equilibrium) approaches

- Initial output is

$$q_1 = \frac{a - 2\,c_1 + c_2}{3\,b} = \frac{33 - 2 \times 15 + 12}{3 \times 1} = 5$$

- Value from lower cost: $5 \times (15 - 12) = 15 \ll 24$
- Firm 2's initial profit levels:

$$\widehat{\pi}_2 = \left(\frac{33 + 15 - 2 \times 12}{3}\right)^2 = \left(\frac{24}{3}\right)^2 = 64$$

- Difference in profit levels: $64 - 25 = 39 \gg 24$

Exchange rate devaluation (again)

- French firm sole domestic producer of a given drug
- Marginal cost: € 2 per dose
- Demand in France: $Q = 400 - 50\,p$ (Q in million doses, p in €)
- Second producer, in India, marginal cost INR 150
- French regulatory system implies firms must commit to prices for one year at a time. Production capacity can be adjusted easily
- Question: Indian rupee is devalued by 20% from INR 50/€. Impact on the French firm's profitability?

Exchange rate devaluation (again)

- Bertrand model seems appropriate
- Initially, $c_2 = 150/50 = € \, 3$
- French firm's profit

$$\pi_1 = (400 - 50 \times 3) \times (3 - 2) = € \, 250\text{m}$$

- Upon devaluation, $e = 50\,(1 + 20\%) = 60, \;\; c_2 = 150/60 = € \, 2.5$
- French firm's profit

$$\pi_1 = (400 - 50 \times 2.5) \times (2.5 - 2) = € \, 137.5\text{m}$$

- So, 20% devaluation implies $(250 - 137.5)/250 = 45\%$ drop in profits

Labor negotiations

- In early 1990s, Ford substitutes robots for fraction of labor force
- In 1993, UAW initiates wage negotiations with Ford. It was expected that similar deal would later be struck with GM, Chrysler
- Ford agreed to what was then generally considered a fairly liberal wage and benefits package with the UAW. Why?
- Marginal cost:
  - $c_i = z + w$, $i = G, C$
  - $c_F = z + (1 - \alpha)\, w$, $\alpha \in (0, 1)$

Labor negotiations (cont)

- Equilibrium profit with 3 firms

$$\widehat{\pi}_i = \frac{1}{b}\left(\frac{a + c_j + c_k - 3\,c_i}{4}\right)^2$$

- Substituting the marginal cost functions given above, we get

$$\widehat{\pi}_F = \frac{1}{b}\left(\frac{a - z - w\,(1 - 3\,\alpha)}{4}\right)^2$$

- $\widehat{\pi}_F$ is increasing in w if and only if $w\,(1 - 3\,\alpha)$ is decreasing in w, i.e., $\alpha > \frac{1}{3}$: raising rivals' costs

Takeaways

- Different models fit different industries better;
  Key question: How easy can output levels be adjusted?
- Comparative statics: by comparing equilibria before and after x estimate impact of x on price, market shares, etc.
- Calibration: Based on historical data (p, q, c, s) estimate values of key model parameters