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Lecture 6

Short-run competition

Industrial Economics

Static competition

- We will take a ***new look*** at a series of models that approach competition when there is ***no time depth***
  collusion – Cournot – Stackelberg – Bertrand
- ***Strategic interaction*** between firms is possible and meaningful
  every firm must ***take into account*** other firms' actions
- ***Barriers*** eliminate the distinction between S-R and L-R
- ***Product differentiation*** may have an impact but is ***not crucial***
  firms are assumed to have ***market power anyway***

Competition with respect to what?

- Firms have to choose in ***which field*** they will compete
  - ***Apple*** and ***Samsung*** are competing with respect to technological advancement
  - ***BMW*** and ***Benz*** are competing with respect to quality
  - ***Coke*** and ***Pepsi*** are competing with respect to advertisement
  - ***DKNY*** and ***Calvin Klein*** compete with respect to design
  - ***Mozilla*** and ***Chrome*** compete with respect to market share
  - ***HSE*** and ***NES*** compete with respect to research
  - ***Oil producing nations*** are competing with respect to quantities
  - ***Supermarkets*** compete with respect to price

Competition in quantities

- *Firm 1* and *firm 2* compete for ***a single period*** by producing ***simultaneously*** a ***homogeneous*** good
- The ***market demand*** is $p(q)$
- The ***cost*** for producing the product is $c(q)$
- Each firm's ***choice*** variable is its own ***quantity***

Collusion

- Let us first assume that the two firms **act as one**
- Profit is
$$\Pi_M = p(q_1+q_2)\cdot(q_1+q_2) - c(q_1+q_2)$$
- Maximizing w.r.t. (q_1+q_2) yields
$$p(q_1+q_2) + (q_1+q_2)\cdot\frac{dp}{d(q_1+q_2)} - \frac{dc}{d(q_1+q_2)} = 0$$
- Which can be written as
$$p(q_1+q_2) = \frac{dc}{d(q_1+q_2)} - (q_1+q_2)\cdot\frac{dp}{d(q_1+q_2)} \quad (1)$$
- That is,
$$p^* = MC + something$$

Cournot (1838)

- Assume now firms ***compete in quantity***, q
- For firm i, $i=1,2$ and $j \neq i$
$$\Pi_i = q_i\cdot p(q_i+q_j) - c(q_i)$$
- Maximizing w.r.t. q_i
$$p(q_i+q_j) + q_i\cdot\frac{p(q_i+q_j)}{\partial q_i} - \frac{c(q_i)}{\partial q_i} = 0$$
- Which can be written as
$$p(q_i+q_j) = \frac{c(q_i)}{\partial q_i} - q_i\cdot\frac{p(q_i+q_j)}{\partial q_i} \quad (2)$$
- That is,
$$p^* = MC_i + something$$

Cournot vs. Collusion

- From (1) and (2) for $i = 1$ and $j = 2$:

$$-(q_1 + q_2)\cdot\frac{p(q_1\ +\ q_2)}{d(q_1 + q_2)} > -q_1\cdot\frac{p(q_1\ +\ q_2)}{\partial q_1}$$

- Because

$$-(q_1 + q_2)\cdot\frac{p(q_1\ +\ q_2)}{d(q_1 + q_2)} > -q_1\cdot\frac{p(q_1\ +\ q_2)}{\partial(q_1 + \bar{q}_2)}$$

- Thus, under Cournot, ***price is higher*** than MC but ***not as high*** as in collusion

Market power in Cournot

- Relationship (2) can be manipulated as

$$p - MC_i = -q_i\cdot\frac{\partial p}{\partial q_i}$$

- Dividing by p and multiplying the RHS with $\frac{q_i+q_j}{q_i+q_j}$

$$\frac{p - MC_i}{p} = -\frac{q_i + q_j}{p}\frac{\partial p}{\partial(q_i+q_j)}\cdot\frac{q_i}{q_i + q_j} \quad \Rightarrow$$

$$L_i = -\frac{s_i}{\varepsilon_d}$$

- ***Lerner's index*** is equal to the ratio of share and brand elasticity of demand at equilibrium

Linear demand – constant costs

- Consider the market demand $p = 1 - q$
- Constant average costs c_1 and c_2
- Profit for firm 1

$$\Pi_1 = (1 - q_1 - q_2)\cdot q_1 - c_1\cdot q_1 = (1 - q_2 - c_1)q_1 - q_1^2$$

- FOC is

$$1 - q_2 - c_1 - 2q_1 = 0 \ \Rightarrow\ q_2 = 1 - c_1 - 2q_1 \quad (R_1)$$

- Similarly, for firm 2

$$q_2 = \frac{1 - c_2}{2} - \frac{1}{2}q_1 \quad (R_2)$$

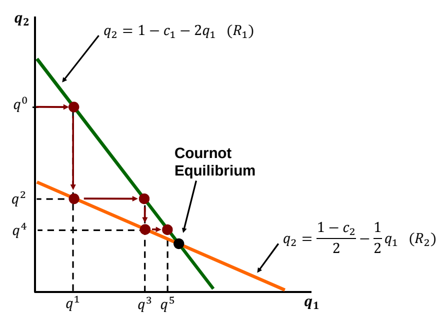
Optimal response

- Conditions (R_1) and (R_2) are the ***optimal response*** or ***reaction functions***
- Their ***simultaneous solution*** is a form of NE

$$q_1^* = \frac{1 - 2c_1 + c_2}{3} \quad \text{and} \quad q_2^* = \frac{1 - 2c_2 + c_1}{3}$$

- Observations
  - Own cost ***reduces*** own share
  - Rival's cost ***increases*** own share
  - Total quantity is ***more*** than monopoly and ***less*** than PC
- This analysis ***carries over*** for more than 2 firms

Stability of the Cournot equilibrium



Cournot with n firms

- Analysis stems from Tirole (p220 – 223)
- n firms each with common average cost c
- For $i = 1, \dots, n$

$$q_i = \frac{1-c}{n+1}, \qquad p = c + \frac{1-c}{n+1}, \qquad \Pi_i = \left(\frac{1-c}{n+1}\right)^2$$

- What happens as $n \to 1$?
- What happens as $n \to \infty$?

Stackelberg (1937)

- What if firms can move ***sequentially***?

  firm 1 ***leads*** and firm 2 ***follows***

- Firm 2, as a follower, exhibits the ***same*** optimal response as in ***Cournot***
- Firm 1, as a leader, can take R_2 ***into account***

$$\Pi_1 = (1 - c_1 - q_2)q_1 - q_1^2 = \left(1 - c_1 - \frac{1 - c_2}{2}\right)q_1 - \frac{1}{2}q_1^2$$

- Maximizing Π_1

$$\frac{d\Pi_1}{dq_1} = 1 - c_1 - \frac{1 - c_2}{2} - q_1 = 0$$

First-mover advantage in Stackelberg

- Optimal quantity for the ***leader*** is

$$q_1^* = 1 - c_1 - \frac{1 - c_2}{2}$$

- And from (R_2), optimal quantity for the ***follower*** is

$$q_2^* = \frac{3}{4}(1 - c_2) - \frac{1 - c_1}{2}$$

- If c_1 is not ***much larger*** than c_2

$$c_1 < \frac{1}{6} + \frac{5}{6}c_2$$

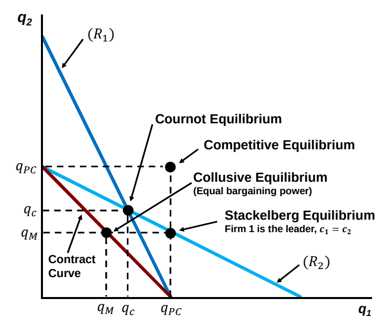
  the leader will sell ***higher quantity*** than the follower

Stackelberg vs. Cournot

- In terms of ***quantity***
  - The leader produces ***more*** than in Cournot
  - The follower ***less*** than in Cournot
  - Total quantity is ***more*** than Cournot
- In terms of ***profits***
  - The leader earns ***more*** than in Cournot
  - The follower earns ***less*** than in Cournot
- ***Price*** is ***less*** than Cournot

  because ***more quantity*** is pushed in the market

Cournot vs. collusion vs. PC – graph



Competition in prices

- Let us now assume that the firms' ***choice variable*** is ***price*** instead of quantity
- To the seller, p and q have an ***one-to-one relationship*** through the demand function
- However, the two are ***fundamentally different*** at a ***strategic level***:
  - Increasing quantity unilaterally, increases market-share and thus ***increases profits***
  - Increasing price unilaterally, decreases market-share and thus ***decreases profits***

Bertrand (1883)

- Firm 1 and firm 2 face ***market demand*** $q(p)$
- ***Cost*** per unit is c
- ***Demand*** for each ***firm,*** $i = 1,2$ with $i \neq j$ is

$$q_i(p_i, p_j) = \begin{cases} q(p_i) & if \quad p_i < p_j \\ 0.5 \cdot q(p_i) & if \quad p_i = p_j \\ 0 & if \quad p_i > p_j \end{cases}$$

- Firms ***simultaneously*** announce ***binding*** prices p_i, p_j

Incentive for deviation

- For any $p_i > c$, firm j has an ***incentive*** to undercut
  - grabs i's entire market share this way
- For any $p_i < c$, firm i has an ***incentive*** to raise p_i
  - i bleeds money if prices below cost
- For $p_i = c$, firm j's best response is to ***match***
  - neither i nor j have an incentive to deviate from this outcome
- ***Marginal cost pricing*** is the ***NE*** in Bertrand!
- This leads to ***zero profit***

$$\Pi_i = (p - c) \cdot 0.5 \cdot q_i\,(p) = 0$$

Bertrand equilibrium

- The zero-profit outcome in Bertrand is ***paradoxical***
  - firms appear to not have any market power
- Notice the ***importance*** of the ***strategic variable***
  - In Cournot a firm believes that its rivals will sell a ***fixed*** quantity
  - In Bertrand a ***slight difference*** in price may change the market shares ***dramatically***
- In Bertrand, ***firms' demand curves*** are ***more elastic*** than under Cournot
  - as a result, the Bertrand equilibrium is ***more efficient***, (greater output, lower prices)

Cournot or Bertrand?

- ***Bertrand*** is more descriptive of actual firm behavior – empirical evidence is more in accord with ***Cournot***
  - Cournot is appropriate when firms are ***capacity constrained*** and investments in capacity are ***sluggish***
  - Bertrand is more appropriate in situations where there are ***constant returns*** and firms can ***easily adjust quantity***
- We must consider the ***ex-ante characteristics*** of the industry
- But also ***test*** the models ex post for applicability
  - whether the model's predictions are ***verified or falsified*** by actual industry behavior

The Kreps and Scheinkman (1983) hybrid

- A **two-stage** game
  - Firms first invest in ***capacity*** and then compete over ***prices***
  - Investment in capacity ***takes time*** and cannot be changed quickly - prices can be adjusted ***easily*** and rapidly
- At the ***equilibrium***
  - Each firm investing in capacity equal to its ***Cournot quantity***
  - Then, the NE in prices, given capacity, has the firms pricing such that they ***produce to capacity***
- The lower the initial investment in capacity the stronger the ***incentive to price more aggressively*** in the second stage

ευχαριστώ!

(thank you!)

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