

Oligopoly (contd.) Chapter 27

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Oligopoly

Considerations:

- Do firms compete on price or quantity?
- Do firms act sequentially (leader/followers) or simultaneously (equilibrium)
- Stackelberg models: quantity leadership
- Cournot equilibrium models: simultaneous choice quantity competition
- Bertrand equilibrium models: simultaneous choice price competition

Today

- Price competition (Bertrand duopoly)
- More quantity competition
 - Stackelberg Duopoly
 - Cartels/collusion

Bertrand Duopoly: price competition

- Firms compete on price
- No clear leader, follower so firms effectively choose p simultaneously
- Take the other firm's price as given
- Market demand determines equilibrium output
- Both choose same price: divide demand evenly
- One sets lower price: that firm captures entire market

Bertrand Duopoly: price competition

- Suppose two firms have same MC
- What price to charge?
- Apply Nash equilibrium
 - Each chooses optimal p_i given p_j
 - No one has incentive to deviate
- If pricing above marginal cost, each has incentive to undercut competitor ($p_i > p_j > MC$ is not an equilibrium)
- $p_i = p_j = MC$ is the only possible equilibrium
- Zero profits for both, but no incentive to deviate:
 - Higher price means no sales
 - Lower price means losses

Stackelberg Duopoly: leader/follower

- Two firms compete in the same market
 - Firm 1 chooses q_1
 - Firm 2 observes q_1 , chooses q_2
 - This determines total Q ...
 - ... which determines price

Stackelberg Duopoly: check your intuition

Clicker Vote

Who has the advantage?

- A) First mover
- B) Second mover
- C) Neither
- D) Depends

Stackelberg Duopoly: how to solve the model

Analyze using *backwards induction*

- Start at the end: what does Firm 2 do given q_1 ?
- Derive *reaction function* just like we did for Cournot
- Then find optimal q_1 , given Firm 1 can deduce 2's reaction

Stackelberg Duopoly: back to our example

Find 2's reaction function (recall: $p = a - Q$, $MC = c$)

- Firm 2's profits, given q_1 :

$$\Pi_2(q_1, q_2) = (p - c)q_2 = (a - q_1 - q_2 - c)q_2$$

implies $q_2^*(q_1) = \frac{a - q_1 - c}{2}$

- Realizing this, 1 factors in 2's response when computing profits:

$$\begin{aligned}\Pi_1(q_1, q_2^*(q_1)) &= (p - c)q_1 \\ &= (a - q_1 - q_2^*(q_1) - c)q_1 \\ &= (a - q_1 - \frac{a - q_1 - c}{2} - c)q_1 \\ &= \frac{a - q_1 - c}{2}q_1\end{aligned}$$

Stackelberg Duopoly: back to our example

$$\Pi_1(q_1, q_2^*(q_1)) = \frac{a - q_1 - c}{2} q_1$$

- Differentiate to find q_1^*

$$\frac{\partial \Pi_1}{\partial q_1} = \frac{a - 2q_1 - c}{2} = 0$$

- Solving yields $q_1^* = \frac{a-c}{2}$
- Plug into reaction function:

$$q_2^*(q_1^*) = \frac{a - q_1^* - c}{2} = \frac{a - \frac{a-c}{2} - c}{2} = \frac{a - c}{4}$$

- Same per unit profit, so $q_1 > q_2 \Rightarrow \pi_1 > \pi_2$
- First-mover advantage

Stackelberg Duopoly: back to our example

Fill in details:

- $q_1^* = \frac{a-c}{2}$, $q_2^* = \frac{a-c}{4}$
- $Q = \frac{3}{4}(a-c)$ so $P = \frac{a+3c}{4}$
- $p - c = \frac{a-c}{4}$, so $\pi_1 = \frac{(a-c)^2}{8}$, $\pi_2 = \frac{(a-c)^2}{16}$, and $\Pi = \frac{2}{16}(a-c)^2$
- $CS = \frac{9}{32}(a-c)^2$ so $W = \Pi + CS = \frac{15}{32}(a-c)^2$

Cartels

Can firms make more profit by colluding and behaving as a monopoly?

- The cartel will behave as if it's a monopoly
- $\implies MR = MC$
- $Q = 1/2$ and $q_1 = q_2 = 1/4$, $P = \frac{a+c}{2}$
- Profits: $\Pi = 1/4$ so $\pi_1 = \pi_2 = 1/8$
- Compare to Cournot: lower Q , CS , W ; higher P , Π

Summary Table

	PC	Mon.	Stck.	Cour.	Cour. (n)	cart.
q_1			1/2	1/3	$1/(n+1)$	1/4
q_2			1/4	1/3	" "	1/4
Q	1	1/2	3/4	2/3	$2/(n+1)$	1/2
P	c	$\frac{a+c}{2}$	$\frac{a+3c}{4}$	$\frac{a+2c}{3}$	$\frac{a+nc}{n+1}$	$\frac{a+c}{2}$
π_1			1/8	1/9	$1/(n+1)^2$	1/8
π_2			1/16	1/9	" "	1/8
Π	0	1/4	3/16	2/9	$n/(n+1)^2$	1/4
CS	1/2	1/8	9/32	2/9	$\frac{1}{2} \frac{n^2}{(n+1)^2}$	1/8
W	1/2	3/8	15/32	4/9	$\frac{n^2+2n}{2(n+1)^2}$	3/8

Note: quantities (q_1 , q_2 , Q) in units of $a - c$; welfare (Π , CS , W) in units of $(a - c)^2$.

Cartels

So what is stopping firms colluding and making more profits?

- Anti-trust regulation
- Ok, but even without regulation, e.g. what problem does OPEC face?
- Collusion is not individually rational: each firm has incentive to cheat and produce more
- E.g. increase q and earn more profit (foreshadowing: how is this like tragedy of the commons?)
- E.g. slightly decrease p and capture entire market
- Cartels can only succeed if they can effectively monitor and punish cheating, which is difficult, esp. if collusion is illegal

Cartels

What are the incentives facing each firm?

Suppose each duopolist can choose to cooperate (**C**) and produce the collusive quantity ($q_i = \frac{a-c}{4}$), or to cheat/defect (**D**) and produce the Cournot quantity ($q_i = \frac{a-c}{3}$).

	C	D
C	$\frac{1}{8}, \frac{1}{8}$	$\frac{15}{144}, \frac{20}{144}$
D	$\frac{20}{144}, \frac{15}{144}$	$\frac{1}{9}, \frac{1}{9}$

Duopolists' Dilemma

Note: $\frac{1}{8} = \frac{18}{144}$ and $\frac{1}{9} = \frac{16}{144}$