Market Power (cont.)

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Why Does the Mode of Competition Matter?

	Bertrand	**Cournot**
Firms choose	Prices	Quantities
Equilibrium P	$= c$	Between c and P^M
Market power	None	Positive
Best responses	Strategic complements	Strategic substitutes
# firms for $P = c$	2	∞

Same industry, same firms, but drastically different predictions. Which model is right?

Intuition for the Difference

Bertrand: A small price cut **steals the entire market** from your rival. Huge incentive to undercut.

Cournot: A small increase in your output has only a **marginal effect** on price and on your rival's revenue. Less aggressive competition.

Key insight: The "sharpness" of competition depends on how sensitive one firm's demand is to the other firm's action.

Capacity Constraints Bridge the Gap

Kreps & Scheinkman (1983): If firms first choose capacity, then compete in prices, the outcome is the **Cournot equilibrium**.

Intuition:

- With limited capacity, undercutting doesn't capture the whole
- Building capacity is like committing to a quantity
- So the real strategic choice is capacity (quantity), and prices adjust

Takeaway: Cournot is a better model when capacity is costly and chosen before pricing. Bertrand is better when firms can flexibly adjust output at their chosen price.

Product Differentiation

Bertrand with Differentiated Products

When products are **not identical**, undercutting doesn't capture the entire market.

Demand:

$$q_1 = a - bp_1 + dp_2 \qquad q_2 = a - bp_2 + dp_1$$

where $b > d > 0$ (own-price effect dominates cross-price effect).

Firm 1 maximizes:

$$\pi_1 = (p_1 - c)(a - bp_1 + dp_2)$$

FOC:

$$a - 2bp_1 + dp_2 + bc = 0$$

Differentiated Bertrand: Solution

Best response:

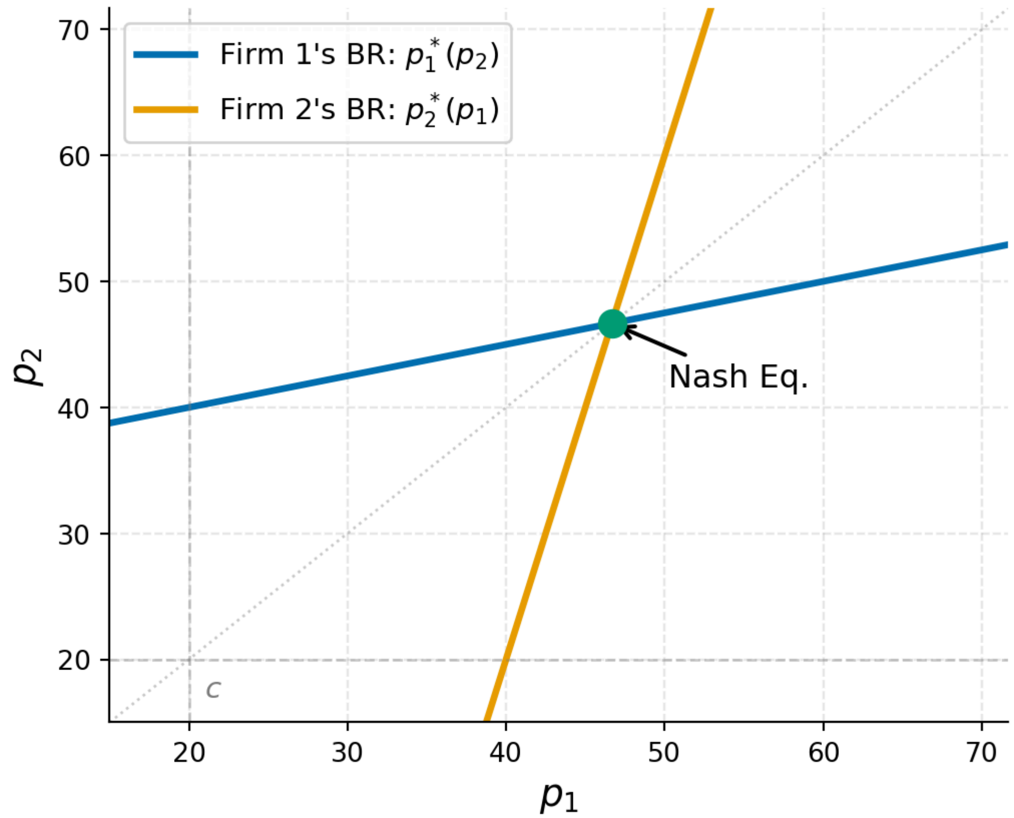
$$p_1^*(p_2) = \frac{a + bc + d\,p_2}{2b}$$

Symmetric equilibrium ($p_1 = p_2 = p^*$):

$$p^* = \frac{a + bc}{2b - d}$$

As long as $c < a/(b-d)$, which is the highest price that yields positive demand, we have $p^* > c$. So firm makes positive profits even with two firms. The Bertrand paradox is resolved!

Prices Are Strategic Complements



Best responses are **upward sloping**: if your rival raises their price, you raise yours. Prices are **strategic complements**.

Tacit Collusion

Can Firms Sustain Higher Prices?

In a **one-shot** Bertrand game: $p = c$ is the only equilibrium.

But firms interact **repeatedly**. Can the threat of future punishment sustain collusion?

Tacit collusion: Firms maintain high prices without an explicit agreement, enforced by the threat of a price war.

Key distinction:

- **Explicit cartel:** Formal agreement (illegal in most countries)
- **Tacit collusion:** Sustained by internal market punishments only

Infinitely Repeated Bertrand

Grim trigger strategy: Both firms charge the monopoly price P^M. If either firm deviates, both revert to $p = c$ forever.

Collusion profit stream (each firm gets half the monopoly profit each period):

$$V_{\text{collude}} = \frac{\pi^M/2}{1 - \delta}$$

Deviation profit: Undercut slightly, capture all monopoly profit for one period, then earn zero forever:

$$V_{\text{deviate}} = \pi^M + 0 + 0 + \cdots = \pi^M$$

When Is Collusion Sustainable?

Collusion is sustainable when $V_{\text{collude}} \geq V_{\text{deviate}}$:

$$\frac{\pi^M/2}{1-\delta} \geq \pi^M \implies \delta \geq \frac{1}{2}$$

If firms value the future enough ($\delta \geq 1/2$), they can sustain monopoly prices.

What makes collusion easier?

- **Higher δ** (patient firms, frequent interaction)
- **Fewer firms** (easier to monitor, each gets a bigger share)
- **Transparent prices** (deviations detected quickly)
- **Stable demand** (fluctuations make it hard to tell if someone deviated)
- **Symmetric firms** (easier to agree on the collusive outcome)

Collusion with n Firms

With n firms splitting monopoly profit equally:

$$V_{\text{collude}} = \frac{\pi^M/n}{1-\delta}, \qquad V_{\text{deviate}} = \pi^M$$

Collusion requires:

$$\delta \geq 1 - \frac{1}{n} = \frac{n-1}{n}$$

n	**Min δ for collusion**
2	0.50
3	0.67
10	0.90

Application: OPEC

OPEC is a real-world example of attempted collusion:

- Member countries agree to production quotas (quantity)
- Each member has an incentive to **overproduce** (cheat on the agreement)
- Collusion harder to sustain when oil prices are volatile (hard to distinguish demand shocks from cheating)
- Saudi Arabia historically serves as the "swing producer" punishing deviators by flooding the market

This is exactly the repeated game logic: collusion sustained by the threat of a price war.

Sequential Competition

Stackelberg Model

What if firms move **sequentially** rather than simultaneously?

Stackelberg model: Firm 1 (leader) chooses q_1 first. Firm 2 (follower) observes q_1 and then chooses q_2.

Solve by backward induction:

Step 1: Firm 2's best response (same as Cournot):

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

Step 2: Firm 1 anticipates this and substitutes into its profit function.

Stackelberg: Leader's Problem

Firm 1 maximizes:

$$\pi_1 = \left[a - b\left(q_1 + \frac{a-c}{2b} - \frac{q_1}{2}\right)\right] q_1 - c q_1$$

Simplifying:

$$\pi_1 = \left[\frac{a-c}{2} - \frac{b q_1}{2}\right] q_1$$

FOC:

$$\frac{a-c}{2} - b q_1 = 0 \implies q_1^S = \frac{a-c}{2b}$$

Follower's response: $q_2^S = \frac{a-c}{4b}$

Stackelberg: Comparing Outcomes

Using $P = 100 - Q$ and $c = 20$:

	Cournot	Stackelberg Leader	Stackelberg Follower
Output	26.67	40	20
Price	46.67	40	40
Profit	711	800	400

The leader produces more and earns more. By committing to a large quantity first, the leader forces the follower to scale back, a **"top dog" strategy**.

Total output is higher and price is lower than Cournot → closer to competition.

Price Leadership

Consider Bertrand game from before with $a = 1, b = 1, d = 0.5, c = 0$.

$$q_i = 1 - p_i + 0.5 p_j$$

Price leadership: Firm 1 (leader) chooses p_1 first. Firm 2 (follower) observes p_1 and chooses p_2.

Follower's best response:

$$p_2^*(p_1) = \frac{1 + 0.5 p_1}{2}$$

Leader's problem:

$$\max_{p_1} p_1 \left(1 - p_1 + 0.5 \left(\frac{1 + 0.5 p_1}{2}\right)\right)$$

Price leadership: Solution

FOC:

$$1 - 2p_1 + 0.25p_1 + 0.25 = 0 \implies p_1 = 0.714$$

Follower's response:

$$p_2 = \frac{1 + 0.5(0.714)}{2} = 0.679$$

	Bertrand	Price Leader	Price Follower
Price	0.667	0.714	0.679
Quantity	0.666	0.625	0.678
Profit	0.444	0.446	0.460

First Mover: Top Dog or Puppy Dog?

Quantity game (Stackelberg): Leader overproduces → **“top dog”** strategy

- Quantities are strategic substitutes (rival’s BR slopes down)
- Aggressive commitment forces rival to back off

Price game (price leadership): Leader raises price → **“puppy dog”** strategy

- Prices are strategic complements (rival’s BR slopes up)
- Gentle commitment induces rival to also raise price

Key insight: Whether the first mover is aggressive or accommodating depends on the slope of the follower’s best response function.

Entry and Exit

Entry and Long-Run Equilibrium

In the long run, positive profits attract **entry**. How many firms will enter?

Setup: Entry requires a sunk cost K. After entry, firms compete à la Cournot.

Equilibrium number of firms n^*: the greatest integer such that:

$$g(n^*) = \frac{(a-c)^2}{b(n^*+1)^2} \geq K$$

The equilibrium number of firms is decreasing in sunk costs K and increasing in market size $(a - c)$.

Strategic Entry Deterrence

An incumbent may try to **prevent entry** rather than accommodate it.

Methods:

- **Capacity pre-commitment:** Build excess capacity to credibly threaten a price war
- **Limit pricing:** Set a low price to signal low costs
- **Brand proliferation:** Fill product space so there's no room for entrants
- **Long-term contracts:** Lock in customers before a rival can enter

Trade-off: Entry deterrence is costly as the incumbent distorts its behavior. Worth it only if the benefit of being alone in the market exceeds the cost of deterrence.

Simple Example of Entry Deterrence

Demand function: $P = 100 - Q$, MC = 0, sunk entry cost K.

To deter entry, incumbent firm 1 will produce a quantity such that even if firm 2 enters and produces its best response, it will not earn enough to cover the entry cost.

Firm 2's best response to firm 1's quantity q_1 is:

$$q_2^*(q_1) = \frac{100 - q_1}{2}$$

Profit for firm 2 if it enters:

$$\pi_2 = q_2^*(100 - q_1 - q_2^*) = \frac{(100 - q_1)^2}{4}$$

Entry Deterrence Example (cont.)

To deter entry, we need $\pi_2 < K$:

$$\frac{(100 - q_1)^2}{4} < K \implies q_1^{det} = 100 - 2\sqrt{K}$$

Firm 1's profit if it deters entry:

$$\pi_1^{det} = (100 - 2\sqrt{K}) \cdot 2\sqrt{K}$$

If firm 1 accommodates entry, it produces $q_1^{acc} = 33.33$ and earns $\pi_1^{acc} = 1111$.

Firm 1 will deter entry if $\pi_1^{det} > \pi_1^{acc}$.

Entry Deterrence Example (cont.)

We need to solve the following equation for K:

$$(100 - 2\sqrt{K}) \cdot 2\sqrt{K} = 1111$$

To simplify, let $x = 2\sqrt{K}$:

$$100x - x^2 = 1111 \implies x^2 - 100x + 1111 = 0$$

Using the quadratic formula:

$$x = \frac{100 \pm \sqrt{100^2 - 4 \cdot 1111}}{2} = \frac{100 \pm 74.54}{2}$$

Using the smaller root ($x = 12.73$): $K = 40.5$. If entry costs are below this, deterrence is not profitable.

The Feedback Effect

An important subtlety for applied work:

- Product differentiation, collusion etc increase profits **holding n fixed**
- But higher profits attract more entry, making the market **more competitive** in the long run
- The short-run and long-run effects of these factors can go in opposite directions

Greater sunk costs constrain entry even in the long run, so prices tend to be higher in industries with large sunk costs.

Summary

Key Takeaways

Models of oligopoly:

- **Bertrand** (price, homogeneous goods): Competitive pricing even with two firms (Bertrand paradox)
- **Cournot** (quantity): Outcome between monopoly and competition; converges to competition as n grows
- **Stackelberg** (sequential quantity): First mover gains by committing to aggressive output

Key Takeaways (cont.)

Resolving the Bertrand paradox:

- Capacity constraints lead to Cournot-like outcomes
- Product differentiation gives firms market power ($p^* > c$ even with two firms)
- Repeated interaction enables tacit collusion if firms are patient ($\delta \geq 1/2$ for duopoly)

Strategic concepts:

- Quantities are **strategic substitutes**, prices are **strategic complements**
- First movers play **"top dog"** in quantity games, **"puppy dog"** in price games
- Entry deterrence trades off short-run costs against long-run monopoly benefits