EconS 305 - Oligopoly - Part 2

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Introduction

- Last time, we looked at Bertrand competition, where firms with market power compete against one another by setting prices.
  - We found that the firms will undercut one another until they both end up charging marginal cost, eliminating all economic profits.
- Today, we'll look at Cournot competition, where firms with market power compete against one another by setting quantities.
  - Will these results still hold?

- **Cournot Competition** is where firms compete in quantities.
  - For simplicity, we will only consider the case where there are two firms, a duopoly, and they sell identical products.
- Each firm individually selects a quantity of output to supply to the market, then the price is determined by the inverse demand curve.
  - As each firm increases their quantity supplied, the price lowers for both firms.

Cournot Competition

- Again, we will use Game Theory to find our solution.
- The firms are the players, but now their strategy could be any quantity. Again, the firms move simultaneously, and the payoffs are once again measured in firm profits.
  - We want to find a best response function for each firm, then see where they intersect to find our equilibrium.
- We can use a bit more math for this type of competition.
  - Yay!

Cournot Competition

- Recall that our inverse demand function is

$$p = 70 - q_1 - q_2$$

  and that our marginal costs are constant at $MC = 10$.
- We want to find firm 1's marginal revenue. We do this the same way we have before by applying the power rule to the total revenue for firm 1,

$$\begin{aligned} TR_1 &= pq_1 = (70 - q_1 - q_2)q_1 = 70q_1 - q_1^2 - q_1 q_2 \\ MR_1 &= 70 - 2q_1 - q_2 \end{aligned}$$

  - Notice that the slope of q_1 doubles, just like before, but everything else stays the same.

Cournot Competition

- To get our best response function for firm 1, we set marginal revenue equal to marginal cost, and then solve for q_1,

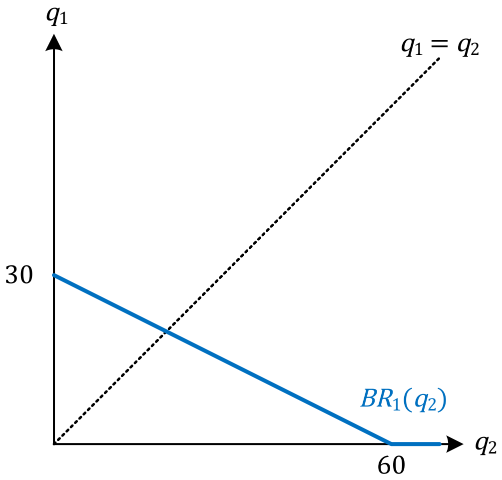
$$\begin{aligned} MR_1 &= MC \\ 70 - 2q_1 - q_2 &= 10 \\ 2q_1 &= 60 - q_2 \\ q_1 &= 30 - \frac{1}{2}q_2 \end{aligned}$$

- What this equation tells us is that for any quantity of firm 2, q_2, the best response is to set

$$q_1 = 30 - \frac{1}{2}q_2$$

  - Let's plot it.

Cournot Competition



Cournot Competition

- First, notice that the best response function for firm 1 is downward sloping.
  - This is because that as firm 2 increases its output, it is better for firm 1 to produce less.
- Also, there is a kink in the best response function at $q_2 = 60$.
  - For quantities of firm 2 that are greater than 60, firm 1's best response would be a negative quantity. Since that's not possible, we say that firm 1 would just produce zero at that amount.
  - This also coincides with both firms receiving zero profits when one of them outputs 60 units.

Cournot Competition

- Before we calculate firm 2's best response function, I wanted to point something out regarding firm 1's best response function.
- Suppose that firm 2 chose the cartel output level, $q_2 = 15$. Would firm 1 also want to produce the cartel level?
  - No! Using firm 1's best response function

$$q_1 = 30 - \frac{1}{2}q_2 = 30 - \frac{1}{2}(15) = 22.5$$

- Firm 1 would produce quite a bit more.
  - Let's look at prices and profits.

Cournot Competition

- Using the inverse demand curve, we can get our new price,

$$p = 70 - q_1 - q_2 = 70 - 22.5 - 15 = 32.5$$

and total revenue and costs for firm 1 of

$$\begin{aligned} TR_1 &= pq_1 = 32.5(22.5) = 731.25 \\ TC_1 &= 10q_1 = 10(22.5) = 225 \end{aligned}$$

yielding profits of

$$\pi_1 = TR_1 - TC_1 = 731.25 - 225 = 506.25$$

- This is much higher than the cartel profits.
  - What about firm 2?

Cournot Competition

- Total revenue and costs for firm 2 are

$$\begin{aligned} TR_2 &= pq_2 = 32.5(15) = 487.5 \\ TC_2 &= 10q_2 = 10(15) = 150 \end{aligned}$$

  yielding profits of

$$\pi_2 = TR_2 - TC_2 = 487.5 - 150 = 337.5$$

- This is much lower than the cartel profits.
  - Firm 1 takes profits away from firm 2 by cheating. Also, the total profits are

$$\pi_1 + \pi_2 = 506.25 + 337.5 = 843.75$$

    which is also less than the total profits under cartel pricing, 900. This is also due to firm 1 cheating, as surplus moves from the producers to the consumers under the lower price.

- Now, to find firm 2's best response function, we want firm 2's marginal revenue, which we get by applying the power rule to firm 2's total revenue,

$$
\begin{aligned}
TR_2 &= pq_2 = (70 - q_1 - q_2)q_2 = 70q_2 - q_1 q_2 - q_2^2 \\
MR_2 &= 70 - q_1 - 2q_2
\end{aligned}
$$

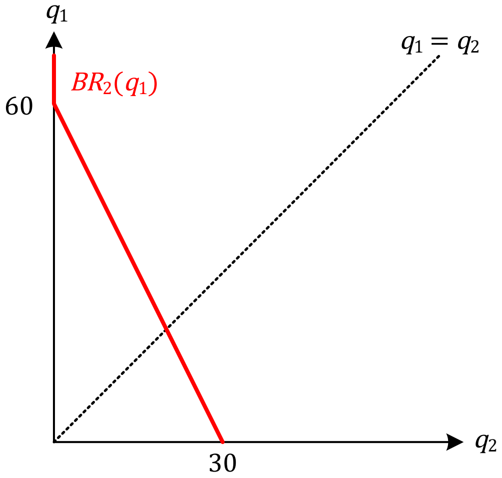
- Setting marginal revenue equal to marginal cost, we can obtain firm 2's best response function by solving for q_2,

$$
\begin{aligned}
MR_2 &= MC \\
70 - q_1 - 2q_2 &= 10 \\
2q_2 &= 60 - q_1 \\
q_2 &= 30 - \frac{1}{2}q_1
\end{aligned}
$$

$$q_2 = 30 - \frac{1}{2}q_1$$

- This looks a lot like firm 1's best response function.
  - It should. Since the firms are identical, their best response functions should be mirrors of one another.
- Let's plot it and see.

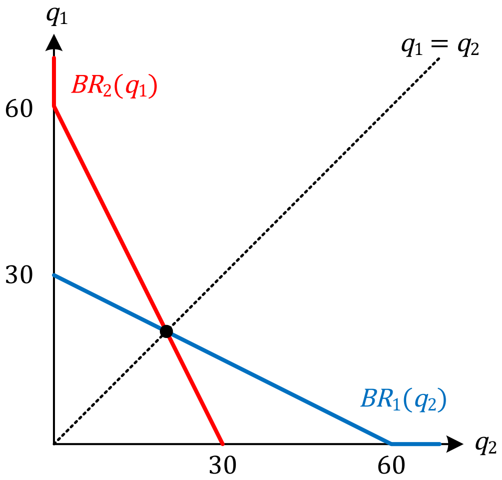
Cournot Competition



Cournot Competition

- Again, we see the same patterns that we did with the best response function for firm 1.
  - It is both downward sloping and has a kink where $q_1 = 60$.
- To find our equilibrium, we just need to find the intersection of the two best response functions.

Cournot Competition



Cournot Competition

- We can find these quantities mathematically. Our two best response functions are

$$\begin{aligned} q_1 &= 30 - \frac{1}{2}q_2 \\ q_2 &= 30 - \frac{1}{2}q_1 \end{aligned}$$

  Rearranging terms, we have

$$\begin{aligned} q_1 + \frac{1}{2}q_2 &= 30 \\ \frac{1}{2}q_1 + q_2 &= 30 \end{aligned}$$

- Let's multiply the second equation by -2.

Cournot Competition

$$\begin{aligned} q_1 + \frac{1}{2}q_2 &= 30 \\ -q_1 - 2q_2 &= -60 \end{aligned}$$

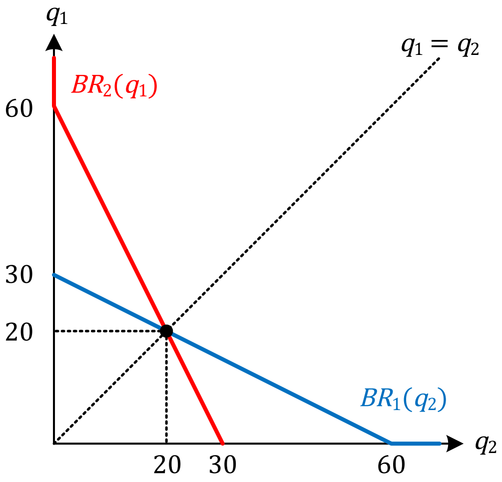
- Now, let's add the equations together

$$\begin{aligned} q_1 + \frac{1}{2}q_2 - q_1 - 2q_2 &= 30 - 60 \\ -\frac{3}{2}q_2 &= -30 \\ q_2^* &= 20 \end{aligned}$$

and plugging this back in to firm 1's best response function,

$$q_1^* = 30 - \frac{1}{2}q_2^* = 30 - \frac{1}{2}(20) = 20$$

Cournot Competition



Cournot Competition

- Now that we have the equilibrium quantities for both firms, we can find the equilibrium price by plugging both quantities back into the inverse demand function,

$$p^* = 70 - q_1^* - q_2^* = 70 - 20 - 20 = 30$$

- From here, we have total revenue and total costs for firm 1 of

$$\begin{aligned} TR_1 &= p^* q_1^* = 30(20) = 600 \\ TC_1 &= 10q_1^* = 10(20) = 200 \end{aligned}$$

and equilibrium profits of

$$\pi_1^* = TR_1 - TC_1 = 600 - 200 = 400$$

- The calculations for firm 2 are identical in this case and

$$\pi_2^* = 400$$

Cartel Comparison

- Let's compare this to the cartel values. Using firm 1 (the results for firm 2 are the same)

	Cartel	Bertrand	Cournot
Quantity	15	30	20
Price	40	10	30
Profits	450	0	400

Cartel Comparison

- In both Bertrand and Cournot competition, the equilibrium quantities were higher, the prices were lower, and the profits were also lower.
  - The incentive to cheat one another drove away producer surplus from the firms and turned it into consumer surplus.

Bertrand vs Cournot

- It's interesting that Bertrand and Cournot competition gives two different results.
  - This is why these two economists didn't get along.
- Who is correct?
  - Realistically, firms don't choose quantities. They just pick the price that they want to sell their stock at.
  - However, Bertrand competition has a very strict assumption. It assumes that when one firm undercuts another, they have enough output to supply the entire market demand. This is rarely the case.

Bertrand vs Cournot

- If we model something known as a **capacity constraint** (a limit to what a firm can supply) into Bertrand competition, it will give essentially the same results as Cournot competition.
- This resolves the issue of the dueling modes of competition.
- For ease in calculation, most economists stick with the Cournot model.

Model Extensions

- We can extend both models by allowing for some product differentiation.
    - This would relax another of the perfect competition assumptions.
- This would involve changing either the demand functions, the cost functions, or both.
    - The analysis, however, is exactly the same as what we did above. Don't be scared.
        - It would be a rather difficult exam question, however.

Summary

- When firms compete, they both have incentives to deviate from the monopoly price.
- Cournot and Bertrand competition produce different results, both of which have merit.
- Competition reduces producer surplus and increases consumer surplus.

Preview for Wednesday

- Competition when firms face different costs.
- What happens when firms move sequentially, rather than simultaneously?
- Also, a fun application with price matching guarantees.

Assignment 7-4 (1 of 1)

1. Consider a two firm duopoly that faces an inverse demand curve of

$$p = 150 - q_1 - q_2$$

and constant marginal costs of $MC = 60$.

   a. If the firms behave as a cartel, what are the equilibrium quantities, price and profits for each firm? (*Hint*: Same question as in the previous assignment)
   b. If the firms compete in quantities (Cournot competition), what are the equilibrium quantities, price and profits for each firm? (*Hint*: Also equal)