Lecture 8: Competition in Prices and Capacities

Primary reference: Besanko, Dranove Shanley and Shaeffer, Economics of Strategy 5th ed., Ch. 8
Overview

- Consider short-horizon (1 or 2 periods) duopoly competition.
- Which characteristics of competition lead to price wars?
- Which characteristics lead to slackened competition?
Brutal Competition - The Bertrand Pricing Model

- Suppose 2 firms produce unlimited capacities of homogeneous products at constant marginal cost 1.
- Suppose there are 3,000 customers each willing to pay up to $2 for one unit.
- They compete for one period.
- They choose prices simultaneously.
- The low-price firm gets all the demand.
- If prices are equal, the firms split demand evenly.
- What is the equilibrium?
Suppose the other firm chooses price \( \hat{P} \) ... what is my best-response?

- If I choose \( P > \hat{P} \), I get a profit of zero.
- If I choose \( P = \hat{P} \), I get a profit of \( 1,500(\hat{P} - 1) \).
- If I choose \( P < \hat{P} \), I get a profit of \( 3,000(P - 1) \).

It is best to choose \( P \) just below \( \hat{P} \). If you make it really, really close, you get (almost) \( 3,000(\hat{P} - 1) \).

The other firm has the exact same incentives to undercut me.
Equilibrium - The Bertrand Pricing Model

- If both firms always have the incentive to undercut, where does it stop?
  - If I choose \( P < 1 \), I get a negative profit on all units sold, which is worse than selling nothing.
  - It stops at marginal cost.

- If the other firm chooses \( \hat{P} = 1 \), I can do no better than to choose price 1.

- The unique equilibrium is marginal cost pricing...essentially a price war. Both firms earn zero profit.
Why is competition so brutal?

- The Bertrand model is unrealistic along many dimensions. The most unrealistic feature is that one firm can, with a small price advantage, capture all demand. This depends crucially on all of the following assumptions:
  - Firms have unlimited capacity to serve demand.
  - Products are not differentiated.
  - Firms have no “captive” customers.
- Without these features, a firm’s ability to capture demand with a price cut is lessened.
- The Bertrand model is an important benchmark because it illustrates the type of market to avoid competing in.
- The one-shot nature of the game is also key to the equilibrium, but we will address that later.
Captive Customers and Price Dispersion

- Many items are priced in a seemingly random way.
- Best Buy does this with prices for high-definition TVs, printers, digital cameras, and many other items.
  - Certain items are “on sale,” with the sale expiring at a known date. Salespeople do not typically know what items will be on sale past a few days from now.
  - The same items sell in other stores, at similar random patterns. At any given moment, you might gain by shopping around.
- Pricing to heterogeneous consumer groups helps us understand the optimality of this phenomenon.
Price Dispersion

- Consider two consumer types...comparison shoppers and those whose demand is inelastic. The latter category represents captive customers.
- If all customers were of the first type, we would see highly competitive pricing.
- If all customers were of the second type, we would see more monopolistic pricing.
- With both types, we see prices fluctuate between competitive and monopolistic levels. How and why?
Price Dispersion: It is all about predictability

- If one store is known to set prices at a particular level, the other firm’s best response is to set prices just a bit lower.
- As in the Bertrand case, this can lead to cutthroat price competition.
- But...given that there are also some customers who do not comparison-shop, the firm does not want to cut prices for them.
- So, what type of equilibrium do we expect here?
Price Dispersion: A mixed strategy equilibrium

By moving its prices around frequently in an *unpredictable* way, the firm discourages the other firms from cutthroat price competition...ideally, it gets the other firms to do the same thing.

Suppose there are two stores selling a cheap item (McAfee uses paper towels) to 3,000 customers. Marginal cost is $1.

Each store has 1,000 captive customers willing to pay $2. There are an additional 1,000 customers who compare prices and buy from the low-price seller.
Price Dispersion: A mixed strategy equilibrium

- The firms choose prices simultaneously.
- The profit to a firm choosing price \( p \) is

\[
\text{Profit} = (p-1)[1,000 + 1,000 \times (\text{the probability } p \text{ is the lowest price})]
\]

- As with previous mixed strategy equilibria, the solution uses backward reasoning...what distribution makes the other firm indifferent between all choices?
- This is a fairly complicated problem, so I’ll just show you the answer.
The equilibrium price is to choose prices randomly between $1.50 and $2 according to the following distribution:

\[ f(p) = \frac{1}{(p - 1)^2} \]
Price Dispersion: Characteristics of the mixed strategy

- The lowest price charged is the average between marginal cost and the price captive customers are willing to pay...this is not a coincidence. By always charging $1.499999, a firm guarantees itself 2,000 customers and makes about 50 cents per customers...the same as charging $2 and always getting only 1,000 customers and making a dollar off of them.

- Lower prices are more likely...that is, items are significantly “on sale” often.

- How could an astute comparison shopper game this system?
Fixed Capacities

- The price dispersion example comes from McAfee Chapter 14.
- It imagines that some customers are “captive,” but we can just as easily motivate it with fixed capacities.
- Suppose that each of the two firms is capable of serving $\frac{2}{3}$ of the 3,000 customers.
- Then, in essence, each firm has 1,000 customers for sure and the two firms compete in prices for the other 1,000.
- The equilibrium is the same.
As Capacities Shrink or as Demand Rises...

- Now consider the case where each firm can serve only 1,500 customers.
- As long as its price is less than $2, the firm’s demand is 1,500 customers.
- Now, it is a monopolist! It can charge $2 and earn profit $1,500.
- Are we beginning to understand the problem faced by airlines during recessions?
Suppose firms simultaneously choose capacities in the first stage, then compete in prices in the second stage. They will not have the incentive to each choose unlimited capacity. This is actually a very complicated problem, but fortunately it has a fairly simple and intuitive solution.
Cournot Competition

Imagine that you are trying to decide how many cases of heirloom tomatoes to bring to the Athens Farmer’s Market.

Once you load up your truck and travel to the market, the choice is irreversible. This is like choosing a capacity. Let the marginal cost of a case be $10.

To keep things simple, suppose that conditional on the total quantity brought by all sellers, the price that emerges is the one that just clears the market. If, for example, inverse demand is given by

\[ P = 100 - Q, \]

where \( Q \) is total cases, and there are two firms who bring \( q_1 \) and \( q_2 \) cases, the price will be

\[ P = 100 - q_1 - q_2. \]
Cournot Competition

- \( P = 100 - q_1 - q_2 \) actually will be the equilibrium price, but the reasons are beyond the scope of this class.
- If the other firm brings 0 cases of tomatoes, then I as firm 1 face a demand curve of

\[
P = 100 - q_1
\]

The optimal output then satisfies
\[
MR = 100 - 2q_1 = 10 = MC, \text{ so that } q_1^* = 45.
\]
- If, on the other hand, the other firm brings 20 cases of tomatoes, then I as firm 1 face a demand curve of

\[
P = 80 - q_1
\]

The optimal output then satisfies
\[
MR = 80 - 2q_1 = 10 = MC, \text{ so that } q_1^* = 35.
\]
Cournot Competition

- You should already be reasoning that neither firm wishes to bring enough tomatoes to serve the entire market.
  - And because of this, competition will not be as tough as in the Bertrand case.

- To some extent, though, the firms must guess how much the other firm is bringing to know how much to bring.

- The problem gets a bit technical here. Generally, firm 1’s marginal revenue, conditional on firm 2 bringing \( q_2 \), satisfies:

\[
MR_1 = 100 - 2q_1 - q_2,
\]

and its \( MC = 10 \). Setting these equal and rearranging a bit, we find

\[
q_1 = 45 - .5q_2.
\]
The function $q_1 = 45 - .5q_2$ characterizes firm 1’s best response to firm 2’s output choice. Similarly, $q_2 = 45 - .5q_1$ characterizes firm 2’s best response.

The Nash equilibrium outputs satisfy both best-response functions.
Cournot Equilibrium - Interpretation

- Each firm guesses that the other firm brings 30 and it is their best-response to also bring 30.
- If the amounts brought differ from these amounts, then one or both of the firms would regret their choice once the choices are revealed.
- If each firm could sequentially refine its choice, the choices would converge to 30.
- The Cournot prediction that firms base capacity choices on expected capacity choices of rivals is confirmed (to some extent) by the experience of the corn wet milling industry in the mid-1970s after the advent of high-fructose corn syrup.
Cournot Equilibrium - Interpretation

- Each firm sells 30 units for $40 per case, earning a revenue of $1200 and a profit of $900.
- Competition is not so tough here. A monopolist would earn $2,025, a bit more than twice what each duopolist earns.
- Neither firm wants to “flood” the market with output, as that would make it difficult to keep prices high.
Cournot with more than 2 firms

- Let \( N \) be the number of firms and let them be symmetric.
- If demand is approximately linear, with y-intercept \( A \), slope \( B \) and marginal cost \( C \), equilibrium profit per-firm is approximately
  \[
  \frac{(A - C)^2}{B(N + 1)^2}
  \]
- Profit decreases as the number of firms increases, but stays positive absent fixed costs.