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**Lecture 20: Oligopoly—Cournot & Stackelberg**

1. Cournot
   1. Augustin Cournot (1836) assumes each oligopolistic firm sets output at the same time. Each firm assumes the others’ production is fixed.
      1. Note the game theory here: keeping the other player’s actions constant, what’s your best strategy?
   2. Thus the price is set by the combined total output.
   3. To illustrate, we will assume two firms. Each has its own demand curve, though each demand curve influences the other firm’s demand curve.
      1. If Firm 1 makes nothing, Firm 2 maximizes profit normally.
      2. If Firm 1 makes 10, Firm 2’s demand curve shifts down by 10 and then Firm 2 maximizes normally.
      3. If Firm 1 makes 20, Firm 2’s demand curve shifts down by 20 and then Firm 2 maximizes normally.
      4. If Firm 1 makes 45, Firm 2’s demand curve shifts down by 45 and then Firm 2 maximizes normally.
      5. It is possible Firm 1 will make so much, Firm 2 won’t want to make anything.
   4. Assume two identical firms (meaning their MC are equal) face the following:
      1. P = 30 – Q (market demand curve)
      2. Q = Q1 + Q2 (each output sums to total output)
      3. MC1 = MC2 = 0
      4. R1 = PQ1 = (30 – Q)Q1 = 30Q1 – Q12 – Q2Q1
      5. MR1 = 30 – 2Q1 – Q2
      6. Set this to zero and Q1 = 15 – 0.5Q2; since marginal costs are the same, Q2 = 15 – 0.5Q1
   5. Substituting one reaction curve for either Q will get you where the curves cross. This is the *Cournot equilibrium*. Since this is an example of Nash Equilibrium (the best one can do holding the actions of the other constant), this is also called Cournot-Nash equilibrium.
      1. Q2 = 15 – 0.5(15 – 0.5Q2) = 7.5 – 0.25Q2 = 10
      2. We can summarize this result graphically:

Q2

Q1

30

25

20

15

10

5

0

5

10

25

15

30

20

**F1**

**F2**

Cournot Equilibrium

Collusive Equilibrium

Competitive Equilibrium

* + 1. Competitive equilibrium is 15 from each firm. Why?
    2. The purple line represents the *collusion curve*—if both firms were to work together, these combined quantities would maximize profits (though they would have to determine a way to split these maximized profits). To find the collusion curve, simply maximize using the total demand curve, as if the firms are operating as one (that is what collusion means, after all). Optimal Q is 15. Since that’s total Q, that 15 will be amount split between the firms. We assume it’s an even split of profit for the collusive equilibrium.
    3. Note how output falls as the market gets less competitive.

1. Stackelberg
   1. We now switch from a simultaneous move game to a sequential move game.
   2. The *Stackelberg model* is similar to Cournot but now we assume that one firm sets output first and the other firm(s) sets output. Suppose Firm 1 sets first and Firm 2 sets second.
   3. Recall how we solve such games: backwards induction.
   4. So we start with Firm 2. Its reaction hasn’t changed.
      1. Q2 = 15 – 0.5Q1
   5. Now recall Firm 1’s total revenue:
      1. 30Q1 – Q12 – Q2Q1, or
      2. 30Q1 – Q12 – (15 – 0.5Q1)Q1 = 15Q1 – 0.5Q12
      3. MR1 = 15 – Q1
      4. Since MC1 = 0, Q1 = 15 and thus Q2 = 7.5
   6. Firm 1 makes twice as much as Firm 2. Note that they are on Firm 1’s reaction curve and not Firm 2’s. Thus we can say Firm 1 is making more than Firm 2. Since the Firm’s are identical (if we reverse the order of play, we would get the same results but swapped) we can say that there is a first mover advantage.
2. Application
   1. Which model is more appropriate depends on the industry. Some industries have strong leaders. Others are more evenly matched.
      1. Example: OPEC during the 70s was the leader in oil production. Stackelberg is more appropriate here which explains why they cut production so much during that time even though they were not the only oil producers.
      2. Example: OPEC now isn’t as powerful, largely because other countries (especially Canada) are now in the mix. Cournot would be more appropriate (though we are closer to perfect competition than an oligopoly there).