Econ 301: Microeconomic Analysis

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Oliogopoly

Motivation

- Today we will apply game theory to markets in particular
- Ideal tool to study the case where we have multiple firms interacting (so not monopoly) but firms are big enough to influence market price (so not pure competition)
  - This is *oligopoly*
- Two simplifying assumptions
  - Just two firms (*duopoly*)
  - Firms are producing identical products (no *product differentiation*)

Overview

- Two possible timings of firm choices
  - Sequential: use backwards induction
  - Simultaneous: use Nash equilibrium
- Two possible choice variables for firms:
  - Price
  - Quantity
- Thus there are four possible models:
  1. Sequential quantity competition (Stackleberg)
  2. Sequential price competition (won't cover this)
  3. Simultaneous quantity competition (Cournot)
  4. Simultaneous price competition (Bertrand)

Sequential Quantity Competition: Setup

- Firm 1 chooses quantity y_1 first (the *quantity leader* or *first mover*)
- Then firm 2 (the *follower* or *second mover*) chooses its quantity y_2
- Total quantity $Y = y_1 + y_2$
- Inverse demand $p(Y) = p(y_1 + y_2)$
- Cost functions $c_1(y_1)$ and $c_2(y_2)$
- Also known as *Stackleberg model*

Sequential Quantity Competition: Solution

- Which solution concept do we use?
- Follower (firm 2) solves
  - Gives us firm 2's *reaction function*: $y_2 = f_2(y_1)$
- Now consider firm 1's (leader's) problem:
  - Note that firm 2's reaction function is in firm 1's problem
  - Solving this problem gives leader's quantity
  - Plug in to find follower's quantity

Example: Linear Demand

- Suppose inverse demand is given by $p(Y) = a - bY = a - b(y_1 + y_2)$
- Assume both firms have zero marginal cost
- What are Stackleberg equilibrium quantities?

Simultaneous Quantity Competition

- Suppose firms both set quantity at same time
- What solution concept should we use now?
- Firm 1's problem:
  - Can be solved to give optimal y_1 as function of y_2: $y_1 = f_1(y_2)$
  - This is reaction function, or best response function
- Similarly, can get firm 2's best response function: $y_2 = f_2(y_1)$

Definition

The Nash equilibrium of the Cournot model (known as Cournot equilibrium) is a quantity pair (y_1^*, y_2^*) such that

$$y_1^* = f_1(y_2^*)$$
$$y_2^* = f_2(y_1^*)$$

Cournot Equilibrium: Example

- Firms face linear inverse demand $p = a - bY$, have zero marginal cost
- What are Cournot equilibrium quantities?

Cournot Equilibrium Graphically

- Note that Cournot equilibrium occurs where reaction functions/best response function cross

Simultaneous Price Setting

- Suppose instead firms simultaneously announce prices p_1 and p_2
- Both firms have constant marginal cost c
- Both firms have capacity to serve entire market
- Firm that announces lower price gets all of market share; if tie, they split market share
- What is the Nash equilibrium?