Economics of Industrial Organization

Lecture 7: Price Competition

베르뜨랑 과점모형

- Strategic variable price rather than output.
- Single good produced by n firms
- Cost to firm *i* of producing q_i units: $C_i(q_i)$, where C_i is nonnegative and increasing
- If price is p, demand is D(p)
- Consumers buy from firm with lowest price
- Firms produce what is demanded

베르뜨랑 과점모형

Firm 1's profit:

$$\pi_1(p_1, p_2) = \begin{cases} p_1 D(p_1) - C_1(D(p_1)) & \text{if } p_1 < p_2 \\ \frac{1}{2} p_1 D(p_1) - C_1(\frac{1}{2} D(p_1)) & \text{if } p_1 = p_2 \\ 0 & \text{if } p_1 > p_2 \end{cases}$$

Strategic game:

- players: firms
- each firm’s set of actions: set of all possible prices
- each firm’s preferences are represented by its profit

베르뜨랑 복점

- 2 firms
- $C_i(q_i) = cq_i$ for $i = 1, 2$
- $D(p) = \alpha - p$

- Profit function is discontinuous, so we cannot use calculus to solve.
- A best response function does not exist.
- Solution method: “see” the solution by logic, prove that it is a solution, prove that no other solution exists.

베르뜨랑 복점

Nash Equilibrium $(p_1, p_2) = (c, c)$

If each firm charges a price of *c* then the other firm can do no better than charge a price of *c* also (if it raises its price it sells no output, while if it lowers its price it makes a loss), so (*c, c*) is a Nash equilibrium.

베르뜨랑 복점

No other pair (p_1, p_2) is a Nash equilibrium since

- If $p_i < c$ then the firm whose price is lowest (or either firm, if the prices are the same) can increase its profit (to zero) by raising its price to *c*
- If $p_i = c$ and $p_j > c$ then firm *i* is better off increasing its price slightly
- if $p_i \geq p_j > c$ then firm *i* can increase its profit by lowering p_i to some price between *c* and p_j (e.g. to slightly below p_j if $D(p_j) > 0$ or to p_m if $D(p_j) = 0$).

Duopoly with different MCs

- Now take the same example, but suppose that the two firms have different marginal costs.
- As before, $D(P) = \alpha - P$
- But now: $C_1(q_1) = c_1 q_1$, but $C_2(q_2) = c_2 q_2$. Assume $c_1 > c_2$.

- Now, no Nash equilibrium exists.
- Clearly, any outcome where $p_1 < c_1$ or where $p_2 < c_2$ is not an equilibrium (at least one firm will earn negative profits and can profitably deviate).
- Any outcome where $\min[p_1, p_2] > c_1$ is not an equilibrium; at least one firm could increase their profit by lowering their price.
- $p_1 = p_2 = c_1$ is not an equilibrium; firm 2 could profitably lower their price.
- $p_1 \geq c_1$, $p_2 < c_1$ is not an equilibrium; firm 2 could increase their price and increase its profit.
- Thus, no equilibrium exists.

상품차별화 Differentiated Product

Cost functions as before ($C(q) = cq$), but now demand function is $q_i = \alpha - p_i + bp_j$, where $\alpha > c$, $0 < b < 2$.

Firm 1 and 2 choose prices simultaneously.

So, now we have a well-behaved problem with continuous profit functions, and well-defined best response functions.

Firm 1 solves: $\max_{p1} (\alpha - p_1 + bp_2)(p_1 - c)$

This gives FOC: $\alpha - 2p_1 + bp_2 + c = 0$

So BR_1: $p_1 = (\alpha + bp_2 + c)/2$

By symmetry, BR_2: $p_2 = (\alpha + bp_1 + c)/2$

Solve these simultaneously to find NE.

$p_1 = [\alpha + b((\alpha + bp_1 + c)/2 + c]/2$

By some algebra, this gives the NE:

$p_1^* = (\alpha + c)/(2-b) = p_2^*$ (by symmetry).

상품차별화 Differentiated Product

- Notice that , given our assumptions on α and b, this price is very clearly > c.
- So, moving to a differentiated product environment, we have got away from the result that we can get competitive prices with only 2 firms from a Bertrand competition model.
- In the real world, virtually all products are differentiated to some extent.

전략적 보완재와 대체재
Strategic Complements vs. Substitutes

- Depending on the particular structure of a game, variables can be strategic substitutes or complements, based on the slope of the best response function.
- Strategies are **strategic substitutes** if in response to another player increasing their strategy, I wish to reduce mine.
- Strategies are **strategic complements** if in response to another player increasing their strategy, I wish to increase mine.
- Cournot: BR_i: $q_i = (\alpha - c - q_j)/2$.
  The BR of firm i is decreasing in the choice variable of firm j, so quantity is a strategic substitute.
- (Differentiated) Bertrand: BR_i $p_i = (\alpha + bp_j + c)/2$.
  The BR of firm i is increasing in the choice variable of firm j, so price is a strategic complement.