14.27 — Economics and E-Commerce Fall '14

Lecture 2 - Review

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4 basic things I want to get across in this review:

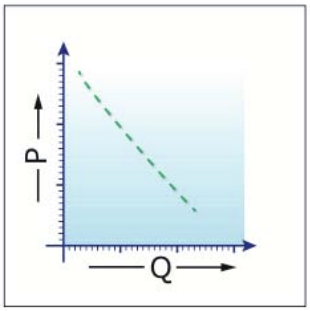
- Monopoly pricing –function of demand, elasticity, & marginal cost
- Simplest model of competition –Bertrand
- How product differentiation affects competition –Hotelling
- How entry affects market outcomes

After the review, I want you to have a few basic, fundamental ideas in your head of how markets work. I will try to emphasize them as we go along.

Review of some basic stuff

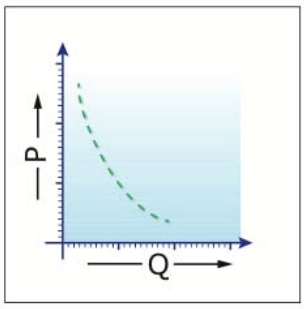
Demand

(e.g. the linear form $Q = a + bP$ and the inverse form $P = \frac{Q-a}{b}$)



- relationship describing how much consumers, in aggregate, are willing to pay for a particular quantity of a good.
- where does it come from?
  - maybe the aggregation of individual utility functions, but we will often be agnostic about its origin –we will just take as given, as firms typically do, and think about how a firm maximizes profits given demand they face.
- could represent total market demand or residual (leftover) from other firms
- could be a function of prices of substitutes or complements, maybe other variables, too

  e.g. $Q = a + bP + cP_s + dP_c$



- recall demand elasticity is defined as $\frac{dQ}{dP}\frac{P}{Q}$ (or $\frac{dQ/Q}{dP/P}$), so if demand takes the convenient form $\log Q = \alpha + \beta \log P + \gamma \log P_s + \delta \log P_c$, the Greek letters are just elasticities:
  - own-price elasticity: $\frac{\partial Q/Q}{\partial P/P} = \frac{\partial \log Q}{\partial \log P} = \beta$ (usually negative)
  - cross-price elasticity (for substitutes): $\frac{\partial Q/Q}{\partial P_s/P_s} = \frac{\partial \log Q}{\partial \log P_s} = \gamma$ (usually positive)
- it is quite common for economists to want to statistically estimate demand curves, and we will see some this semester, but we won't be overly concerned with the mechanics of doing the estimation
- just be familiar with the idea of aggregate demand curve and how we get elasticity estimates from it

Costs

- total, marginal, average variable, etc.
- just be aware of two types of costs included in the total cost $C(Q)$:
  - fixed costs, F, are independent of output (e.g., building a brewery, setting up a website)
  - marginal cost, c or $c(Q)$, is the incremental cost of producing one additional unit (e.g., additional fuel needed for extra passenger on an airplane, wholesale cost of goods being resold)
- we often assume for modeling purposes that marginal costs are constant (c)
- sometimes whether a cost is fixed or variable depends on the range of production you're considering
  - e.g., if output fluctuates $\pm$ 20%, current office space and staff is fine, otherwise need to expand or contract

Monopoly behavior

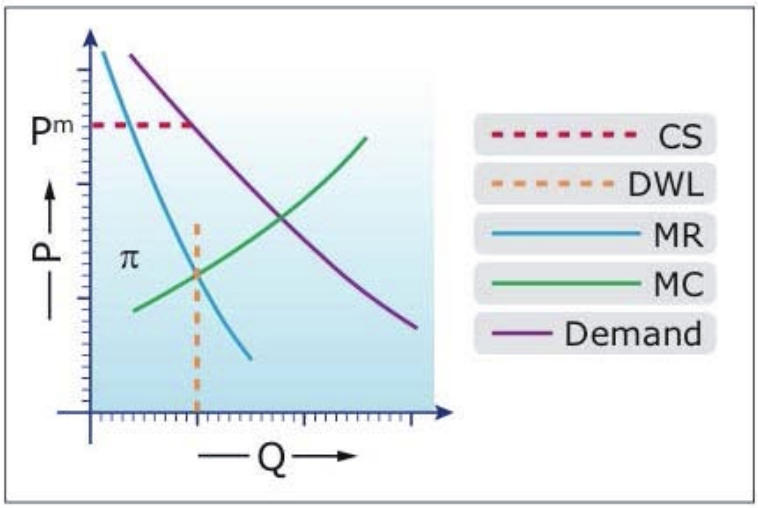
- monopolist maximizes profit
- has costs $C(Q)$ (where C is total cost, not marginal cost) and faces inverse demand $P(Q)$
- wants to max $P(Q)Q - C(Q)$ for Q, via first-order condition:

$$\underbrace{P'(Q)Q + P(Q)}_{\text{MR}} - \underbrace{C'(Q)}_{\text{MC}} = 0$$

rewrite:

$$\underbrace{\frac{P(Q) - C'(Q)}{P(Q)}}_{\substack{\text{Lerner Index, describes markups that firms set over marginal cost}}} = \frac{-QP'(Q)}{P(Q)}$$

$$= \frac{-1}{\epsilon} \text{ (where } \epsilon = \frac{P}{Q}\frac{\partial Q}{\partial P}\text{)}$$



- so elasticities determine markups & they're higher when demand is inelastic
- also note that price does not depend on fixed costs, only marginal

This is a very powerful & important result for our intuition of how firms price. I wrote this down in the monopoly case, but intuition (sometimes) carries over to non-monopoly case if $P(Q)$ is residual demand.

Strategic Behavior in Oligopoly Markets

So far this semester, we've been talking about firms making decisions in isolation - monopolists must consider consumers when deciding how to price, how many & what quality products to offer, etc, but not competition. It's a useful benchmark and, in fact, some of the results we saw in monopoly have counterpart results with similar flavor in markets where multiple firms operate. One important element these models did not capture: if you're a firm operating in a market with other firms, their actions affect you, your actions affect them, and all of you should consider those affects when making decisions. That's what we'll all about next and for most of the remainder of the semester.

Bertrand Paradox: developed by Joseph Bertrand in 1883

Let s start with the simplest model of two firms competing in price that we could write down

- assume 2 firms (generalizes in straight-forward way to n firms)
- identical products, so consumers buy from producer with lowest price
- firms set prices and there is a split market if prices are equal, so the monopoly model is nonstrategic
- with market aggregate demand is $Q = D(P)$ and constant & common marginal cost of production, c:

$$\Pi^i(P_i, P_j) = (P_i - c)D_i(P_i, P_j)$$

$$\text{where } D_i(P_i, P_j) = \begin{cases} D(P_i) & \text{if } P_i < P_j \\ \frac{1}{2}D(P_i) & \text{if } P_i = P_j \\ 0 & \text{if } P_i > P_j \end{cases}$$

- firms choose prices simultaneously (they cannot observe rival's price) & non cooperatively

The common solution is a concept in game theory known as a Nash equilibrium. For prices, this is a pair (P_1^*, P_2^*) where each firm's price maximizes its profit given the other firms price, so no one wants to deviate from the equilibrium. Formally, this is:

$$\Pi^i(P_i^*, P_j^*) \geq \Pi^i(P_i, P_j^*)$$

What is that equilibrium? $P_1^* = P_2^* = c$

Proof:

- suppose $P_1^* > P_2^* > c$
  - firm 1 has zero demand & zero profit
  - if, instead, $P_1 = P_2^* - \epsilon$, it obtains entire demand $D(P_2^* - \epsilon)$ and has positive margin $P_2^* - \epsilon - c$ (and therefore positive profit) $\Rightarrow\Leftarrow$
- now suppose $P_1^* = P_2^* > c$
  - profit of firm 1 is $\frac{D(P_1^*)(P_1^* - c)}{2}$ but if it reduces price to $P_1^* - \epsilon$, its profit becomes $D(P_1^* - \epsilon)(P_1^* - \epsilon - c)$, which is greater for small ϵ $\Rightarrow\Leftarrow$

- now suppose $P_1^* > P_2^* = c$
  - firm 2 makes no profit & could raise its price slightly, still supply all demand, and make positive profit $\Rightarrow\Leftarrow$
- so both firms price at marginal cost and make no profit

Notes:

- this result suggests the monopoly results we saw before are very special –even a duopoly restores perfect competition
- we call it a paradox, though, because it seems so at odds with casual empiricism
- we also call it a paradox because we think all firms incur fixed costs of some type & if they enter even a duopoly market of this type they can never cover their fixed costs

Discussion

The Bertrand Paradox is stylized model, for sure, but not an unreasonable setup –the results, though are paradoxical. What is going on? There is a special set of important assumptions underlying the results:

- consumers assumed to know both prices
- demand has this knife-edge quality
- firms only set price once
- firms can meet all demand immediately

Note: because we can criticize the model does not mean it's not valuable. It represents a very real tendency that firms must work hard to escape, and these criticisms of the model do suggest ways in which firms competing can escape the Bertrand Paradox and charge enough to cover fixed costs and make positive profit.

So, how do firms escape the Bertrand Paradox?

- product differentiation
  - products are not identical
    - e.g., spatial differentials between coffee shops or dry cleaners
  - firms can take actions to further differentiate their products from rivals
    - e.g., various characteristics in cars
- consumer search
  - consumers do not always know prices (or product characteristics) of all products
    - e.g., shopping for rugs in Turkey
  - firms can take actions to further obfuscate and make search more difficult
    - e.g., it can be costly to drive to five different mattress stores and when you do, retailers rename particular models of mattress to make comparison across retailers difficult.
- repeated interactions
  - firms don't simply meet once and set price once. it turns out that many more equilibria are possible when firms interact over and over.
    - e.g., gasoline stations across the street from each other

- capacity constraints
  - firms who cannot immediately meet all demand are credibly committing not to undercut rivals
  - firms foresee this and may not invest in additional capacity to maintain this commitment
    - think about two hotels in small town, either one too small to satisfy market demand (at typical prices) alone
    - they will not engage in cutthroat competition then and also won't increase capacity in the long run because they expect keen competition in the situation of collective overcapacity

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