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Concepts from the Theory of the Firm:

K/S Chapter 2: Part 2.5, Imperfect Competition

Important Acknowledgement:

These notes on Kirschen/Strbac (Chapter 2, Part 2.5) are based on slides prepared by Daniel Kirschen (University of Manchester) with substantial edits by Leigh Tesfatsion (Iowa State U).

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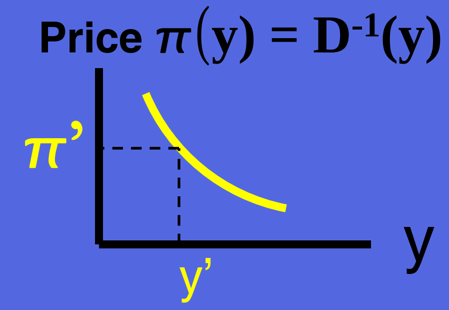
Imperfect Competition

- One or more "strategic player" firms can influence the market price through their actions
- Strategic player firms
  - Can influence the market price through their actions (price SETTERS rather than price takers)
  - Perceive and actively exploit potential demand for their output
  - Do not have "supply curves" in previously developed sense
  - Typically have a large market share of capacity/output/revenues
- A "competitive fringe" could still exist
  - Participants with a small market share
  - Take the market price as given
- ***Examples:*** Monopoly (single seller) models, Cournot and Bertrand multi-seller models of competition

Single-Price Monopoly Models

- A firm is a ***monopoly*** if it is the only supplier of a product y for which there is no close substitute.
- A monopoly that is limited to charging the same price π for each unit of its product y is called a ***single-price monopoly.***
- This is the case treated in Kirschen/Strbac, Chapter 2, Section 2.5.3.

Single-Price Monopoly…Cont'd



- A single-price monopolist perceives it faces a downward sloping inverse demand curve $\pi(y) = D^{-1}(y)$.
- The monopolist exploits this knowledge by setting its price equal to $\pi(y) = D^{-1}(y)$ = (maximum willingness of buyers to pay for y), given it produces y.
- The monopolist sets its price with no worry this price can be undercut by ***existing*** rivals.
- However, *new* market entrants could be a concern, i.e., the market could be ***contestable*** .

Marginal Revenue for a Single-Price Monopolist

- ***Total Revenue Function:*** TR(y) = π(y)•y

- ***Marginal Revenue Function:***

$$
\begin{aligned}
MR(y) &= \frac{dTR(y)}{dy} \\
&= \pi(y) + \frac{d\pi(y)}{dy} \cdot y \\
&= \pi(y) + \frac{d\pi(y)}{dy} \cdot \frac{y}{\pi(y)} \cdot \pi(y) \\
&= \pi(y) \left[1 - \frac{1}{\mid \epsilon(y) \mid} \right]
\end{aligned}
$$

- **Note:** MR(y) < π(y) unless demand is perfectly elastic (i.e., $\varepsilon(y) = -\infty$)

Profix Maximization for a Single-Price Monopolist

- **Basic Observation:**

  A small increase in output by a monopolist will ***increase*** its net earnings if MR > MC and ***decrease*** its net earnings if MR < MC.

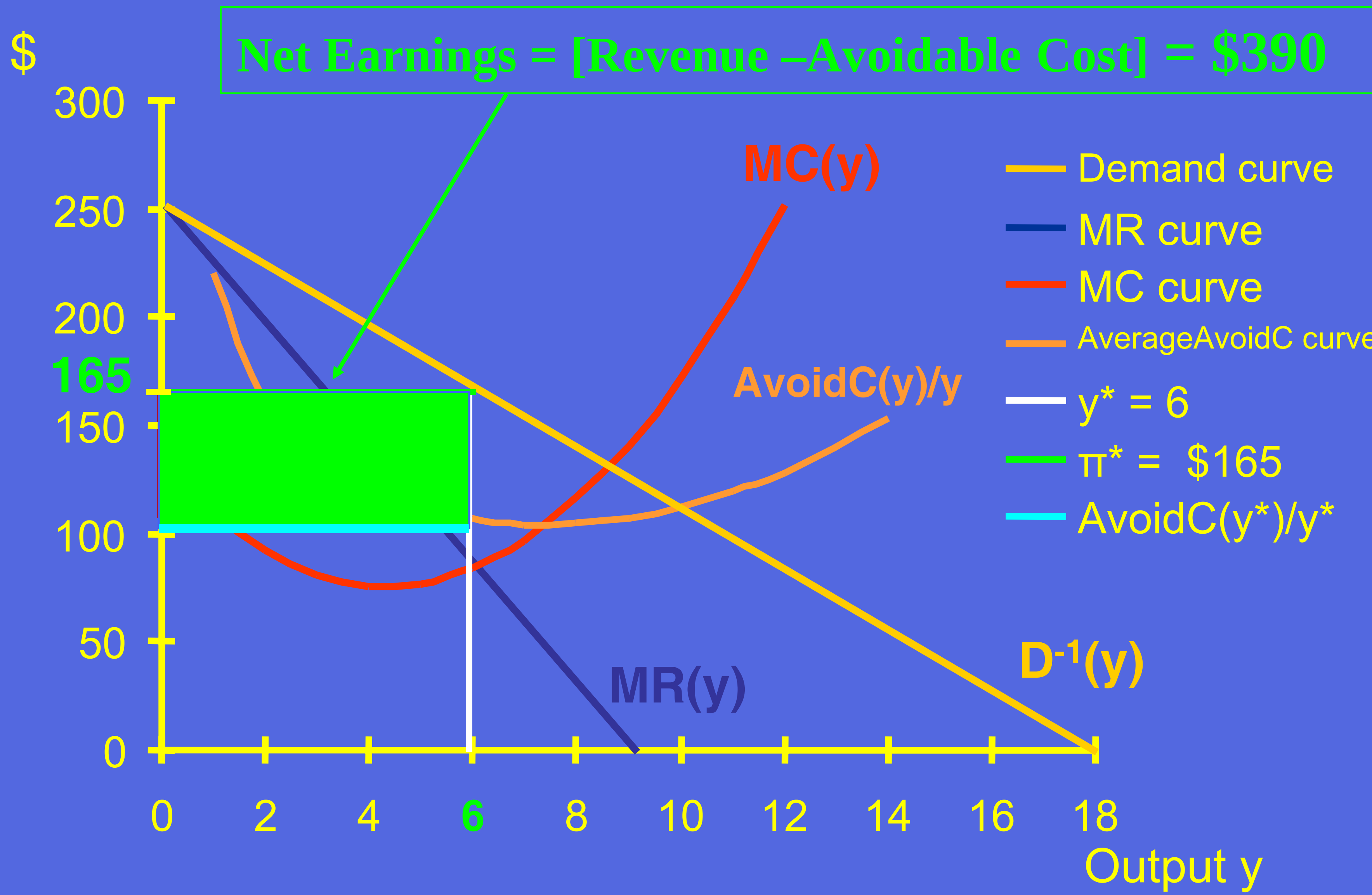
- ***Single-Price Monopolist's Short-Run Optimization Rule:***

  - Increase output if MR > MC ;
  - Decrease output if MR < MC ;
  - Choose output y* where MR(y*) = MC(y*) and set price π^* equal to the consumer's maximum willingness to pay at y*, i.e., set

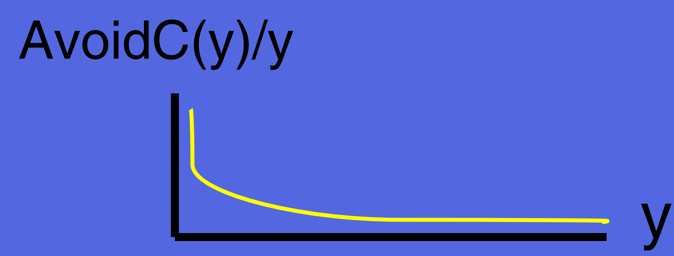
    $$\pi^* = \pi(y^*) = D^{-1}(y^*) .$$

  - If revenue $\pi^* y^*$ is at least as great as avoidable costs at y*, i.e., at least as great as AvoidC(y*) = [C_v(y*) + AvoidFC] = [VariableCost(y*) + Avoidable Fixed Cost], then produce y*. Otherwise, shut down.

Single-Price Monopolist's Profit Maximization:



Natural Monopoly

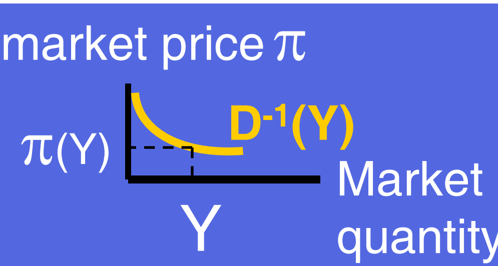


- A production process is said to exhibit ***economies of scale*** if average avoidable costs of production decrease with increases in production.

- A production process is said to be a ***natural monopoly*** if it exhibits such extensive economies of scale that one monopolist firm can meet all demand at a lower average avoidable cost than two or more firms.

- ***Key Issue for Power Industry:*** What aspects of electric power production (if any) are properly considered to be “natural monopolies” and hence potential candidates for regulation?

Cournot Duopoly (Two-Firm) Model of Quantity Competition:



Let $Y = y_1 + y_2$, and let $\pi(Y)$ = market price given Y.

Problem for firm 1: $\max_{y_1} [\pi(y_1 + y^e_2)\, y_1 - AvoidC(y_1)]$

$$\Rightarrow \quad y_1 = f_1(y^e_2) \qquad (y^e_2 = \text{expected } y_2)$$

Similar problem for firm 2:

$$\Rightarrow \quad y_2 = f_2(y^e_1) \qquad (y^e_1 = \text{expected } y_1)$$

Cournot-Nash Equilibrium:

$$\left.\begin{aligned} y_1^* &= f_1(y_2^*) \\ y_2^* &= f_2(y_1^*) \end{aligned}\right\} \text{ fulfilled firm expectations}$$

Neither firm has any incentive to deviate from the equilibrium

Cournot Oligopoly (Multi-Firm) Model:

Total industry output: $Y = y_1 + \cdots + y_n$, $s_i = y_i / Y$

Firm i:

$$\max_{y_i} \{ y_i \cdot \pi(Y) - AvoidC(y_1) \}$$ (AvoidC(y) = C_v(y) + AvoidFC)

$$\frac{d}{dy_i}\{ y_i \cdot \pi(Y) - c_v(y_i) \} = 0$$

$$\pi(Y) + y_i \frac{d\pi(Y)}{dy_i} = \frac{dc_v(y_i)}{dy_i}$$

$$\pi(Y)\left\{ 1 + \frac{y_i}{Y}\frac{Y}{dy_i}\frac{d\pi(Y)}{\pi(Y)} \right\} = \frac{dc_v(y_i)}{dy_i}$$

$$\pi(Y)\left\{ 1 - \frac{s_i}{|\varepsilon(Y)|} \right\} = \frac{dc_v(y_i)}{dy_i}$$

This equals 1 for perfect competition because $d\pi/dy_i=0$

This equals $1 - | 1/\varepsilon(Y) |$ for a monopolist (i.e., when n = 1)

Cournot Oligopoly Model … Continued

$$\pi(Y)\left\{1-\frac{s_i}{|\varepsilon(Y)|}\right\}=\frac{dc(y_i)}{dy_i} = MC(y_i)$$

< 1 except for perfect competition case $\varepsilon(Y) = -\infty$

- Cournot firm i operates at a point where its marginal cost $MC(y_i)$ is ***less*** than the market price $\pi(Y)$
- Ability of a Cournot firm i to advantageously deviate from "competitive" $\pi(Y) = MC(y_i)$ point is a function of:

1) Market share $s_i = y_i / Y$

2) Inverse of price elasticity of demand $1/\varepsilon(Y) = \frac{d\pi(Y)}{dy_i}\frac{Y}{\pi(Y)} < 0$

Cournot Oligopoly Model…Continued

- We can now complete this model in the same way we did for the duopoly case (N=2)
- Consider the following equation:

$$\pi(Y)\left\{1-\frac{s_i}{|\varepsilon(Y)|}\right\}=\frac{dc_v(y_i)}{dy_i}$$

- Let Y be replaced by [$y_i + h(y^e_{-i})$] = Sum of y_i plus expected outputs for all firms other than firm i
- Then optimal y_i choice for each firm i can be expressed as a function $y_i^* = f(y^e_{-i})$ of the expected output of other firms.
- ***Cournot-Nash equilibrium*** holds at $y^* = (y^*_1,\ldots,y^*_N)$ if

$y^*_i = f(\, y^*_{-i}\,)$ for each firm i (i.e., all firms have correct expectations at y*)

Bertrand Duopoly (Two-Firm) Model of Price Competition

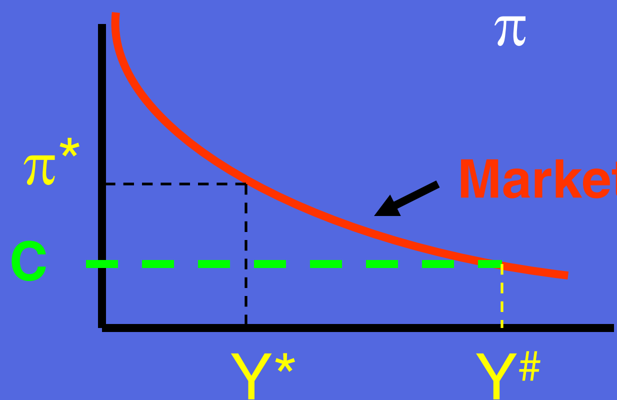
- Two identical firms with constant marginal cost of production, c, are competing for demand

- Each firm offers a price with the promise to supply all quantity demanded from it at that price

IF a firm was a **monopolist**, it would solve:

$$\max_{\pi} \; [\, \pi D^{o}(\pi) - cD^{o}(\pi) \,] \Rightarrow \pi^{*}[1 - 1/|\varepsilon^{*}|\,] = c$$

$$(\text{with } \varepsilon^{*} = \varepsilon(\pi^{*}) < 0\,)$$



Bertrand Duopoly … Continued

- However, the firm that sets the lowest price captures the entire market, so firms have an incentive to undercut each other's price offers
- Neither firm will bid below its marginal cost of production, c, because it would sell at a loss
- Thus the only Nash equilibrium is when each firm sells at the same price $\pi^{\#}$, equal to the marginal cost of production c
- Price=MC: Equivalent to competitive equilibrium!
- Note that the division between the firms of the output $Y^{\#}$ resulting when $\pi^{\#} = c$ is indeterminate.