C50 Lecture 10

Regulation of Natural Monopoly
Goals and challenges of natural monopoly regulation

Objectives

– Allow firm to recover its costs
– Provide incentives for productive efficiency
– Provide price signals for efficient resource utilization
– Provide correct incentives for entry

• Difficulties

– Public utilities require long lived, sunk investments
– Multiple products
– Increased competition at industry “boundaries”
– Technological change
The “simple” regulatory rule: \( P = AC \)

BASIC MONOPOLY MODEL (Declining ATC)

\[
D(Q) = a - bQ, \quad MR(Q) = a - 2bQ, \\
ATC = (F/Q) + c, \quad MC = c.
\]

- \( MR = MC \) \( \Rightarrow P^M \Rightarrow DWL_{\text{MONOPOLY}} \)
- \( P = MC \) \( \Rightarrow DWL = 0 \) but \( \Pi < 0 \)
- \( P = ATC \) \( \Rightarrow DWL_{\text{REGULATE}} \)

\[
DWL^M > DWL^R > DWL^C = 0 \\
Q^M < Q^R < Q^C \\
P^M > P^R = ATC > P^C = MC.
\]
The Rate Case: ensuring cost recovery

The fundamental rate case equation:

\[ RR_t = sRB_{t-1} + OE_t + D_t \]

revenue requirement = fair rate of return on rate base value + operating expense + depreciation expense

Operating Expenses include the usual variable costs of the firm: i.e., items that an accountant would **expense**

- Labor
- Materials
- Etc.
Depreciation expense: Recovering the costs of long-lived assets

Prices recover investment costs over time

What does “average cost” mean in this situation?

Traditional accounting rules

- Depreciation charges recover asset costs
- Time pattern of depreciation charges
  - Straightline: $D_t = \frac{V_0}{T}$
  - Accelerated: $D_t < D_s$ for $t > s$

- Example: $V_0 = $1000; $T = 2$; $Q_1 = 60$ and $Q_2 = 40$
- What’s “AC” of this machine?
  - $10 = \frac{($1000)}{(60+40)}$?
- Straight-line depreciation: $D_1 = D_2 = $500
  - “AC$_1$” = $500/60 = $8.33$
  - “AC$_2$” = $500/60 = $12.50
- Accelerated depreciation: e.g., $D_1 = $600 > $400 = D_2$
  - “AC$_1$” = $600/60 = $10.00$
  - “AC$_2$” = $400/40 = $10.00
Determining the fair rate of return

Average of “debt” and “equity” costs of capital
- But the firm chooses its debt/equity ratio

Cost of debt capital relatively easy to measure

Issues in determining cost of equity capital
- Appropriate adjustment for “risk”
  - But regulatory process influences risk
- Measuring investors’ expectations of future performance; i.e., implementing
  - \( k = \frac{\text{Div}}{\text{Price}} + g \)
- A bonanza for Finance professors!
Rate structure: raising the revenue requirement

With 2 or more products, there are typically an infinite number of ways to satisfy the revenue requirement

Which prices should be “high” or “low” a major source of controversy in regulatory proceedings

- Regulatory statutes typically contain “fairness” provisions and prohibit “undue discrimination”

What are the economic principles that should be used?

- Ramsey pricing principles (Chapter 11) provide answer based upon surplus maximization and presumption of monopoly
Fully distributed cost pricing

FDC attempts to determine the costs of individual services. Each service recovers the costs unambiguously assigned to it plus an allocated “fair share” of overhead costs. Allocation rules base upon “objective criteria”

- Volume
- Attributable costs

Example:
- Output: $Q_1 = Q_2 = 100$
- Attributable costs per unit: $c_1 = 5$, $c_2 = 10$.
- Overhead costs:
  - $F_1 = 700$ if only service 1
  - $F_2 = 500$ if only service 2
  - $F = 900$ if both provided
- Allocation using relative volume:
  
  \[
  C_1 = c_1 Q_1 + Q_1 F/(Q_1 + Q_2) = 950 \\
  C_2 = c_2 Q_2 + Q_2 F/(Q_1 + Q_2) = 1450
  \]

- Allocation using relative attributable costs:
  
  \[
  C_1 = c_1 Q_1 + c_1 Q_1 F/(c_1 Q_1 + c_2 Q_2) = 800 \\
  C_2 = c_2 Q_2 + c_2 Q_2 F/(c_1 Q_1 + c_2 Q_2) = 1600
  \]
Economically meaningful multiproduct cost concepts

Total costs of the enterprise (C) depend on all output levels.

Marginal cost of any service $i$ (MC$_i$) is the cost of producing one more unit of that service.

Stand-alone costs of a service $i$ (SAC$_i$) are the costs of providing only that service.

Incremental costs of any service $i$ (IC$_i$) are the added costs incurred because a service is provided.

\[ IC_i = C - SAC_{\text{others}} \]

AVERAGE COSTS do not exist!

- Example:
  - Total and marginal costs are
    \[ C = F + c_1 Q_1 + c_2 Q_2 = 900 + 50 + 1000 = 2400 \]
    \[ MC_1 = c_1 = 5 \]
    \[ MC_2 = c_2 = 10 \]
  - Stand-alone costs are
    \[ SAC_1 = F_1 + c_1 Q_1 = 700 + 500 = 1200 \]
    \[ SAC_2 = F_2 + c_2 Q_2 = 500 + 1000 = 1500 \]
  - Incremental costs are
    \[ IC_1 = C - SAC_2 = F - F_2 + c_1 Q_1 = 400 + 500 = 900 \]
    \[ IC_2 = C - SAC_1 = F_1 - F + c_2 Q_2 = 200 + 1000 = 1200 \]
Cross-subsidization: When is a rate structure “subsidy free?”

Total revenues equal total costs
  – If not, the *firm* is either providing or receiving a subsidy
Revenues from a service must not exceed the *stand-alone costs* of the service
  – If they do, the service is *providing* a subsidy
Revenues from a service must not be less than *incremental costs* of providing that service
  – If they are, the service is *receiving* a subsidy

- Total revenues equal total costs
  \[ p_1 Q_1 + p_2 Q_2 = F + c_1 Q_1 + c_2 Q_2 = 2400 \]
  \[ p_1 + p_2 = 24 \]

- Stand-alone cost tests
  \[ p_1 Q_1 \leq SAC_1 = 1200 \]
  \[ p_1 \leq 12 \]
  \[ p_2 Q_2 \leq SAC_2 = 1500 \]
  \[ p_2 \leq 15 \]

- Incremental cost tests
  \[ p_1 Q_1 \geq IC_1 = 900 \]
  \[ p_1 \geq 9 \]
  \[ p_2 Q_2 \geq IC_2 = 1200 \]
  \[ p_2 \geq 12 \]
Efficiency of the rate structure: Peak-load pricing

The “Peak-Load” Problem
- Demand varies cyclically (e.g., daily, monthly, yearly)
- Capacity cannot be varied over the cycle
- Output cannot be stored

Economic efficiency issues
- How are marginal costs defined?
- Should prices be set equal to short-run or long-run marginal costs?
- How to recover capacity costs?

- Basic Model:
  - Independent demands
    \[ D_{\text{peak}} = D_1(p) > D_2(p) = D_{\text{off peak}} \]
  - Capacity K must be sufficient to meet demand
    \[ K \geq D_1(p_1) \geq D_2(p_2) \]
  - Per unit capacity costs = \( \beta \)
  - Per unit variable costs = b
  - LRMC = b + \( \beta \)
  - SRMC = b
  - Total costs
    \[ C = \beta K + b(D_1 + D_2) \]
Case I: Firm Peak

Peak period price equals long-run marginal costs
\[ p_1 = b + \beta \]

Off-peak price equals short-run marginal cost
\[ p_2 = b \]

Peak-period users “pay” for all capacity costs
\[ (p_1 - b)D_1 = \beta D_1 = \beta K \]

Uniform pricing
- Results in deadweight loss
- Does not involve cross-subsidy
Case II: Shifting Peak

Output in both periods fully utilizes capacity

\[ D_1(p_1) = D_2(p_2) = K \]

Unequal prices:

\[ \beta + b > p_1 > p_2 > b \]

\[ (p_1 - b) + (p_2 - b) = \beta \]

Note that

- Both prices above SRMC
- Both prices below LRMC
- Both period contribute toward covering capacity costs
A Cookbook for solving peak-load pricing problems

Identify peak and off-peak periods
Try setting peak price equal to \( b + \beta \), off-peak price equal to \( b \)
  – If “peak” quantity greater than “off-peak” quantity at those prices, you’re done. If not,
Construct the demand for capacity schedule by adding together the inverse demand schedules (less variable cost) for each period:
  – \( P_K(K) = (P_1(K)-b) + (P_2(K)-b) \)
  – (Remember, you’re now in the shifting peak case, so \( K = Q_1 = Q_2 \))
Solve for the intersection of the demand for capacity schedule with the marginal cost of capacity: i.e., set \( P_K(K) = \beta \) and solve for \( K \)
Plug this value of \( K \) back into the inverse demand functions
\( p_1 = P_1(K) \) and \( p_2 = P_2(K) \)