
Chapter 6: Quantitative Techniques in Regulation

Quantitative Methods for
Regulation and Competition

Regulation of a Natural Monopoly

- Examples: electricity network and distribution, telephone service, natural gas distribution, water supply,...
- Benefits: reduce allocative inefficiency
- Costs:
 - Direct: regulatory burden
 - Indirect: side effects
- Focus on price regulation

Regulatory Objectives

- **Allocative efficiency**
 - price reflect costs
 - optimal product variety and quality
- **Productive efficiency**
 - costs are minimised
 - dynamic as well as static
- **Redistribution**
 - minimise excess profit
- **Regulatory burden**
 - informational requirements; monitoring
 - regulatory costs; lobbying

Price regulation

- How costs are taken into account?
- Regulator sets ρ , P_o such that $P(c) = \rho P_o + (1-\rho)c$
 1. Fixed price ($\rho = 1$)
 - strong incentive to minimise costs, firm keeps benefit
 - but price may depart from cost
 2. Set price = cost ($\rho = 0$)
 - no excess profit
 - but little incentive to minimise costs
 3. Intermediate ($0 < \rho < 1$):
 - *More cost sensitive (smaller ρ), less risk borne by the firm*
 - *However, less incentives to improve efficiency*
- In practice, most regulated systems are intermediate

Rate of Return Regulation (US)

- Start with (2) in prev slide. Revenues = Costs (or Profits = 0):

$$\sum_{i=1}^n p_i q_i = C + s(B)$$

- p_i , q_i price and quantity of service i (n is the number of services)
- s is the allowed or “fair” rate of return,
- C is the firm’s operating expenditures and
- B is the firm’s installed capital base (value of firm’s investment)

- Divide the process in two:
 - Rate-level problem (finding s , appropriate level of return on investment)
 - Rate-structure problem (finding p_i ’s, price discrimination among groups or products)

Remark

- Regulatory lags provide some incentives to minimise costs:
 - Once the rate level and rate structures are set, they remain unchanged until next rate case
 - During this period, regulated firms have incentives to be cost efficient
 - However, this may be very short (one year) (there might be distributional losses)

Rate Level

- What are the legitimate expenses (RHS)?
 1. Expenses (fuel costs, wages, taxes, depreciation)
 - Are salaries of top management too high?
 - If buying inputs from a subsidiary, are prices too high?
 2. Return on investment:
 - What constitutes the rate base?
 - Original cost method: amount paid less depreciation
 - Reproduction cost: what would be the production costs today?
 - Replacement cost
 - Market capitalisation
 - What is the proper rate to investment?

Rate of Return

- The allowed rate of return s is...
 - Based on the estimated costs of capital (how much expected returns do the investors require?)
 - Bonds, (preferred stocks) and common stocks
 - Weighted by their percentage of capitalisation
 - For example:

	Percent of capitalisation	Percent Cost
Bonds	48	9.34
Preferred Stock	14	8.22
Common Stock	38	12.5
	100	10.4 (Weighted average)

Cost of Capital

- Bonds and preferred stocks less controversial: costs easily determined
- What should be the cost of common stock?
 - Denote by k (e.g. $k=12.5$ in the previous slide)
 - Accounting methods
 - CAPM or APT
- Quantitative technique (1):
 - Estimating the weighted average cost of capital

Rate Structure

- How prices vary across customer classes and products
- Average pricing rules:
 - Allocate costs to the different groups
 - Difficult and may be arbitrary
- Ramsey pricing:
 - Prices such that firm breaks even and the efficiency loss is minimised

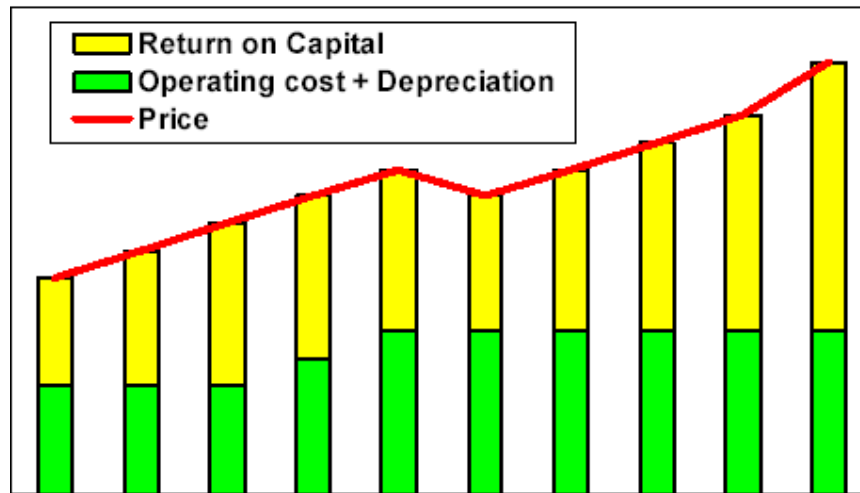
Price Cap (UK)

- Average prices can increase by $RPI - X$ in a year, the cost index minus productivity gain:
 - Idea: incentives to eliminate inefficiencies and pass the benefits to the consumers through lower prices
 - Cap applies to a basket of prices (weighted average) if multiproduct firm
- Elements:
 - Cost index not industry-specific: retail price index (RPI)
 - X can change year to year but is fixed (and exogenous to the firm) between price reviews
 - X based on past performance and on projected analysis of productivity gains
 - X may be firm-specific

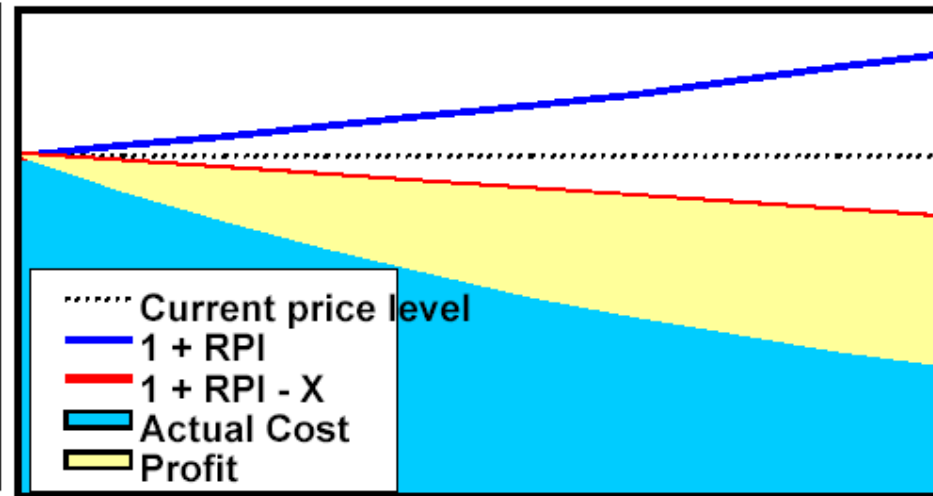
Remark

- Prices are not completely independent of costs:
 - Sometimes + K added to the equation, allowing pass-through of exogenous costs (e.g. generation costs for electricity supply companies)
 - During the periodic reviews, costs are taken into account

Rate of Return Regulation



Cap Regulation



■ Rate of Return:

- Revenue/price follow costs
- Disadvantages: Frequent regulatory reviews (costly) and informational problems
- Advantages: Predictable and transparent

■ Cap regulation:

- Revenue not linked to current costs
- Disadvantages: Quality may suffer (control needed)
- Advantages: High-powered incentives

Littlechild Report (1983)

- Criteria for assessing regulatory regimes
 - protect consumers against monopoly power
 - encourage static and dynamic efficiency
 - minimise burden of regulation
 - promote competition
 - proceeds from privatisation and firm prospects
- Regulatory regimes considered:
 - rate of return regulation
 - output-related profits levy
 - profit ceiling
 - price cap

} Profit regulation

} Price control

Littlechild's assessment

- Profit regulation undesirable
 - poor efficiency incentives; distorts investment
 - covers whole business, not only monopoly services
- Recommended price cap
 - protects against monopoly
 - good incentives for efficiency
 - low burden: calculate simple price indices
 - potential entry incentives for long-distance market

Periodic review

- X must be reset in the periodic review
- Regulatory review typically takes account of
 - operating costs; expected productivity and demand growth
 - asset values; allocation between regd and unregd business
 - cost of capital
 - future investment requirements
 - extent of competition (possible regulatory withdrawal)
- Rate of return elements are also considered here

Productivity Gains and Benchmarking

- One approach: base productivity gains on previous gains achieved in the previous period (incentives?)
- Benchmarking (or yardstick competition): compare the firm with a comparator (“shadow firm”)
 - Identify an attainable cost level (opex and capex, separately?) and apply a catch-up efficiency target
 - Price setting less influenced by own costs (better incentives)
 - May overcome information asymmetry
- Currently extensively used in practice, not only in UK
- Creating a shadow firm? Quantitative techniques:
 - Regression analysis (RA)
 - Productivity indices (TFP)
 - Data Envelopment Analysis (DEA)
 - Stochastic Frontier Analysis (SFA)

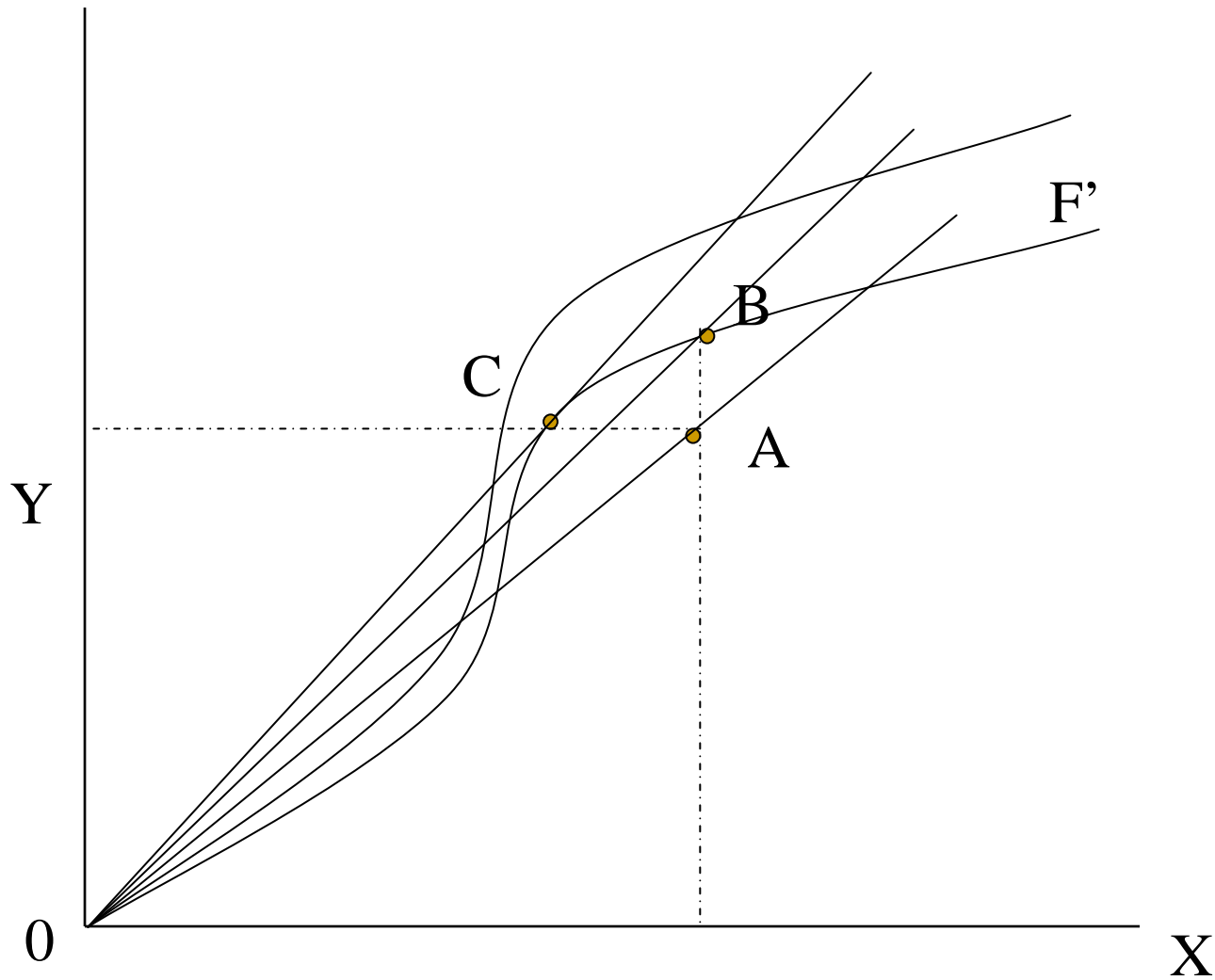
Criticisms to Benchmarking

- Selection of the appropriate model?
- Accuracy of the efficiency scores
- International benchmarking?
- Costs imposed on the industry
- Uncertainty

Some Definitions

- **Productivity (Total Factor Productivity):**
 - Ratio of output it produces to the input it uses
 - If more than one, then indices need to be created
- **Production frontier:**
 - Maximum attainable output for each level of input (see next slide)
- **Technical efficiency:**
 - Operating in the production frontier (e.g. B and C)
- **Economies of scale:**
 - Improve productivity (e.g. from B to C)
- **Technical change:**
 - Advances in technology that expand the production set
 - E.g. new boiler for a coal-fired power plant

Production Frontier and Technical Efficiency



Quantitative Techniques (2)

- Estimating production functions:
 - May be used to evaluate technical change (aggregate time-series data)
 - May provide measures of relative efficiency, by comparing a firm with respect to the averagely efficient firm (firm-level data)
- Constructing TFP indices:
 - Objective: measure changes in the levels of output produced and levels of input used (aggregate time-series data)

Quantitative Techniques (3)

- **DEA:**
 - Linear programming technique (firm-level data)
 - Provide measures of relative efficiency, by compute distances from the frontier
- **Stochastic Frontier Analysis:**
 - Econometric technique (firm-level data)
 - Again, provide measures of relative efficiency, accounting for the presence of measurement error