"Power Market in India - Way Forward"
26-28 April, 2017
IIT Kanpur

Economics of Power Market

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Power Market

- How does electricity differ from other products?

Electricity – Defining the product

- Location
- Time
- Duration
- Quality
- Reliability

- Path Dependency – needs transmission network

Describing a Power Market

Geographical Coverage

- Intra-state
- Inter-state
- Supra-national (Regional)

Time Period

- Long-term
- Medium-term
- Short-term

Describing a Power Market (Contd.)

Scope of Competition

- Negotiated
- Regulated
- Competitive Tendering
- Power Exchanges

Scope of Participation

- Generators (including captive) and Discoms
- Traders and PXs
- Limited Customer Access
- Full Retail Competition

Negotiated Contracts in Power Markets

- Negotiated PPAs directly between generator and distribution utilities (subject to regulatory approval)
- Short-term contracts brokered by registered traders (generally not subject to regulatory approval for price but for over all procurement limit for ST power procurement)

Typical Characteristics of Infrastructure/Power Sector

- Technical characteristics
- Economic characteristics
- Socio-economic and organizational characteristics

Technical characteristics

- Input into production
- Technical indivisibity (lumpiness of investment)
- Immobile
- Long life
- Assets not widely traded
- Exclusion could be technically difficult

Economic characteristics

- Reduction of transaction costs
- Sub-additive cost function i.e. there are conditions for natural monopoly
- High sunk costs
- Network externalities
- Little rivalry in consumption

Socio-economic and organizational characteristics

- Necessity of centralized planning and coordination
- Traditionally publicly owned but increasing private-public cooperation
- Sometimes considered citizen right (State should assure a minimum supply)

Infrastructure/Electricity Provision & Need for Economic Regulation

- In in historic times, Kings built bridges, canals etc.!
- In modern times, ownership and operation of infrastructure is undertaken by the governments. While Policy/Regulation, Ownership and Operation was embedded with government, role of regulation was often ignored.

Need for Economic Regulation

- Inadequate and poor quality of services, and poor financial performance under public ownership.
- Private ownership and operation brings in a concern of private monopoly for government as well as consumers .

Economics of Regulation

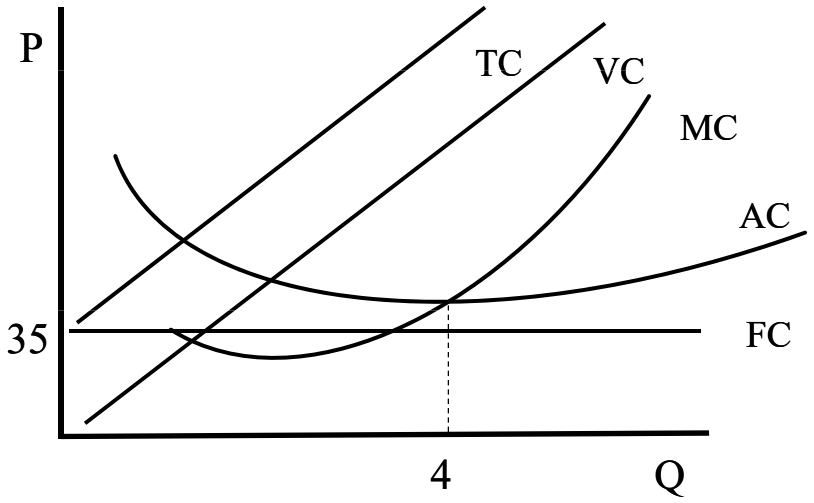
- Perfect Competition - Pricing
- Monopoly - Pricing
- Consumer & Producer Surplus
- Market Failures
- Economic Regulation
- Pricing for Natural Monopoly

Concepts of Perfect Competition and Monopoly

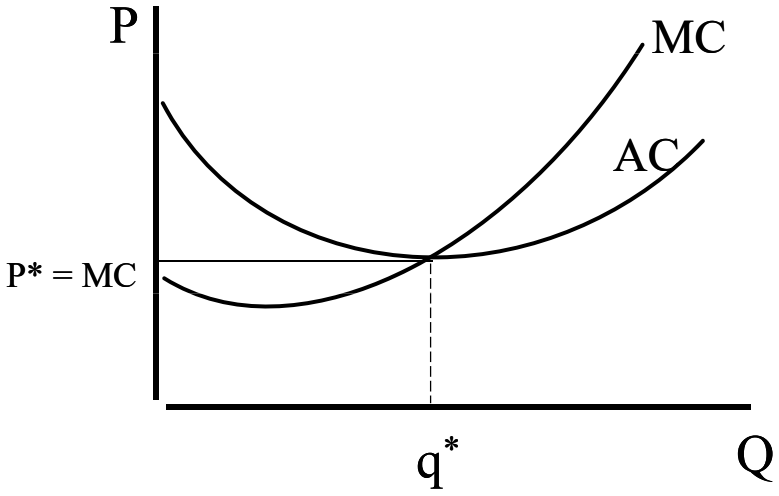
Perfect Competition - Characteristics

- Large number of buyers and sellers, each acting independently
- No buyer or seller is so large to influence the market
- Homogeneous product
- No barriers to entry or exit
- No artificial restraint on prices
- Perfect information
- Profit maximizing firms
- Perfect mobility of factors of production

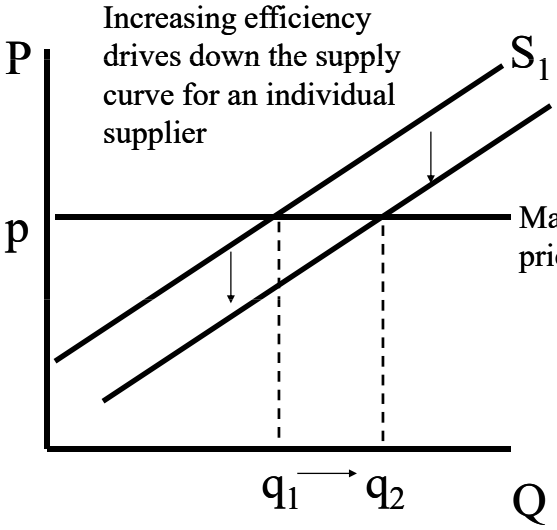
Cost Concepts



Pricing – Perfect Competition Outcome for firm



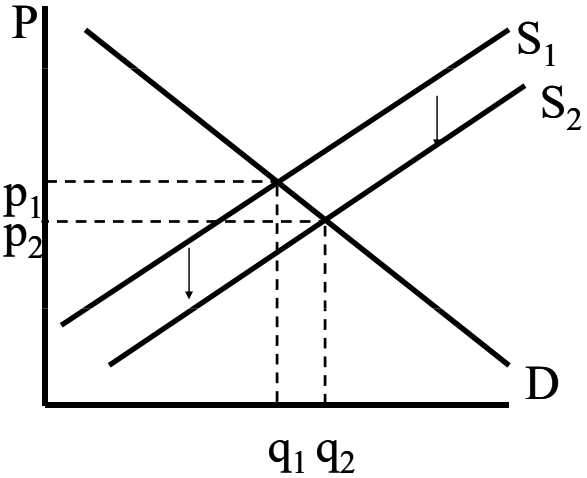
Why companies care about costs



Competitive markets give good incentives for efficiency and innovation

Producer is able to sell more; total revenue increases, so does total profit

Benefits of competition

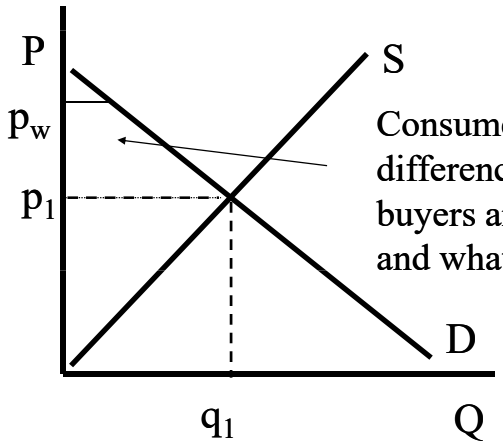


As companies compete with each other, costs are driven down

Consumer benefits:

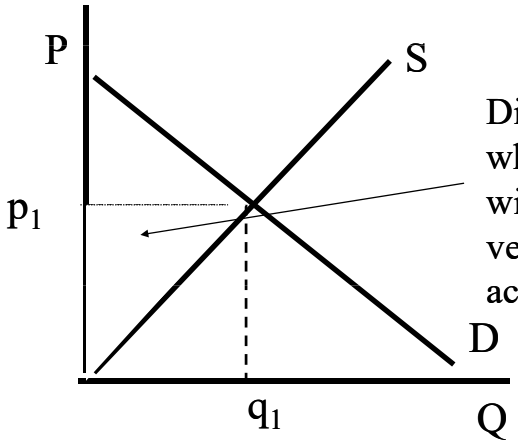
Prices are cut to p_2 and demand rises to q_2 as a result of competition

Consumer surplus



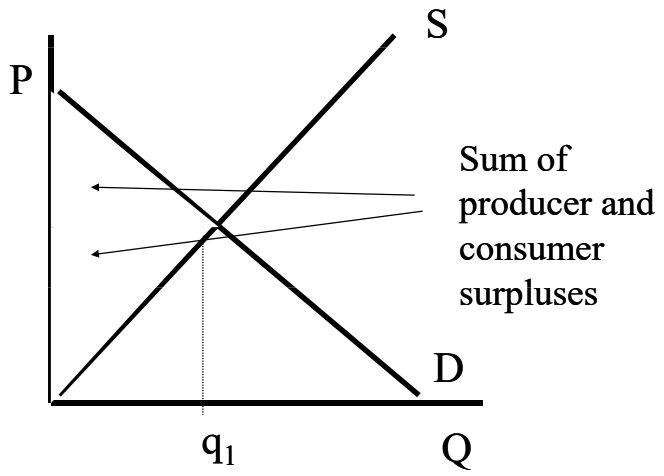
Consumer surplus: the difference between what buyers are willing to pay and what they have to pay

Producer surplus



Difference between what producers are willing to sell at versus what they actually get

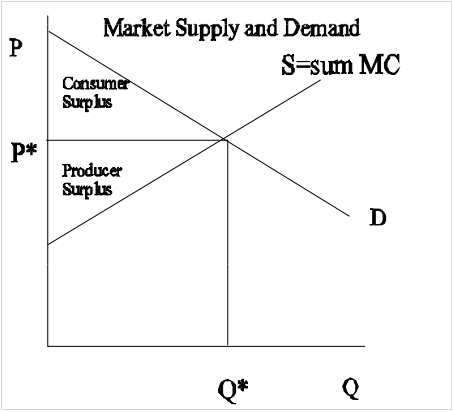
Total surplus



Perfect Competition

- Social Welfare

- Efficiency in Production - incentive to produce at lowest possible cost
- Efficiency in Allocation - right amount of good is produced since MC to produce equals marginal willingness to pay equals price



Concepts of Monopoly

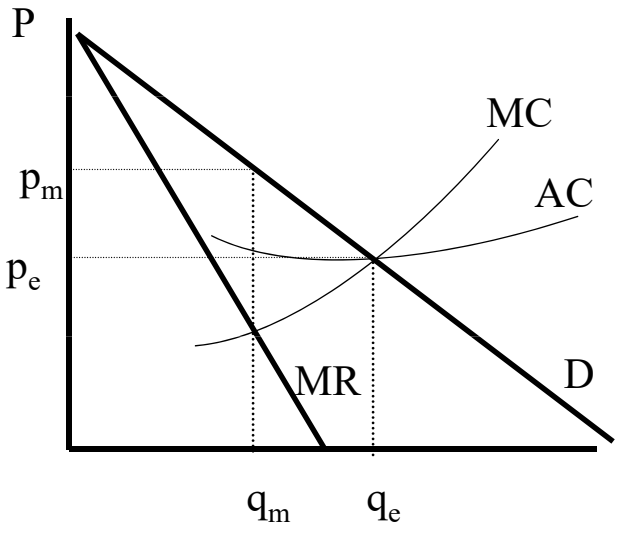
Monopoly

- Single producer/supplier of products
- Price set by the Monopolist
- Faces no competition due to entry barriers:
  - High entry costs (capital investment)
  - Licensing (legal)
  - Technology/IPR - patents, copyrights
  - Natural monopoly

Monopoly behaviour

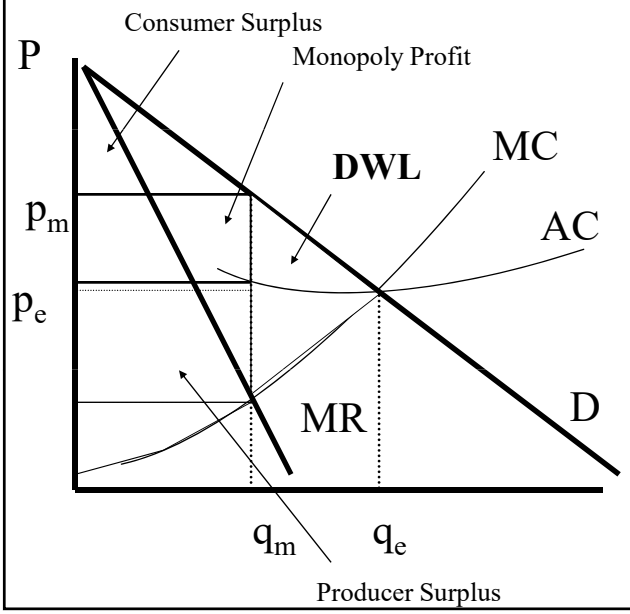
- Objective: maximize profit
- Chooses quantity to sell/produce that maximises profits.

Monopoly: Price Setting



Monopolist sets quantity where profits are greatest, output at which MR=MC

Monopoly: How society looses



Monopolist captures part of consumer surplus.

Consumer surplus lower compared to competitive market case.

"deadweight loss"; social loss as compared to perfect competition

Monopoly Outcomes as compared to perfect competition

- Sells less quantity
- The sold quantity is at a higher price
- Lower consumer surplus
- Higher producer surplus – transfer of surplus from consumers to producers
- Total surplus is lower. Dead weight loss.
- X-inefficiency - firm doesn't work hard to cut costs.

Market Failures

Sometimes markets can fail to operate in beneficial way and lead to inefficienct allocation of resources. There are three main classes of market failure:

- Market Power
- Externality
- Information asymmetry

Appropriate regulations are design to address the above market failures.

Market Failures (contd.)

- Market Power – Ineffective competition; actual or potential; Monopoly, cartel, monopsony; (special case - Natural Monopoly)
- Externality - behaviour of one firm affects others for reasons other than prices (when firms or people impose costs or benefits on others outside the marketplace)
- Information asymmetry – consumers do not have enough information about the goods that they buy

Natural Monopoly

- Industry cost is minimised by having only firm in the industry.
- Average costs are declining.
- Natural monopolies are likely to exist when there is large fixed-cost component to cost. (fixed costs are large as compared to marginal cost).

Natural Monopoly (contd.)

- In case of natural monopoly – allocative and productive efficiency can not exist together.
- Productive efficiency requires that only one firm produces all output (cost minimised).
- Such firm will fix prices above cost to maximise profits – allocative efficiency is violated.
- For allocative efficiency – a number of firms need to compete to bring prices down to marginal cost (P = MC).

Externality

- Actions of agent A effect the welfare of B.

Negative externality

e.g. environmental pollution, fishing

Positive externality

e.g. beekeeper & farmer

Information Asymmetry

- Infn may not only be imperfect but also asymmetric
- Eg. “Market for lemons”

Why Regulation?

- Regulation – restrictions on decision of economic agents (Firms, consumers)
- Rationale for Regulation
  - Market Power - Natural Monopoly
  - Externality
  - Information asymmetry

} Market Failure

Types of Regulation

- Antitrust Policy (licensing / certifications) - seeks to protect consumers from anticompetitive behavior through the judicial system (MRTP / Competition Act)
- Direct Regulation or Economic Regulation - controls pricing and/or output due to the belief that the industry is inherently Monopolistic (Power, Telecom etc.). Market power is the main focus of utility regulation.

Types of Regulation (contd.)

- Social Regulation - controls undesirable consequences of firm behavior to obtain various social goods such as clean air and water, safe products and workplaces.
  (Pollution Control Acts, Safety Regulations etc.);
- Technical - licensing requirements, drug regulations, quality certifications like BIS etc., safety in nuclear plants, water flow in hydro plants

Economic Regulation - What can be regulated ?

- Price
- Quantity
- Entry & Exit
- Quality
- Investment
- Access to Resources

Economic Regulation - What can be regulated ? (Contd.)

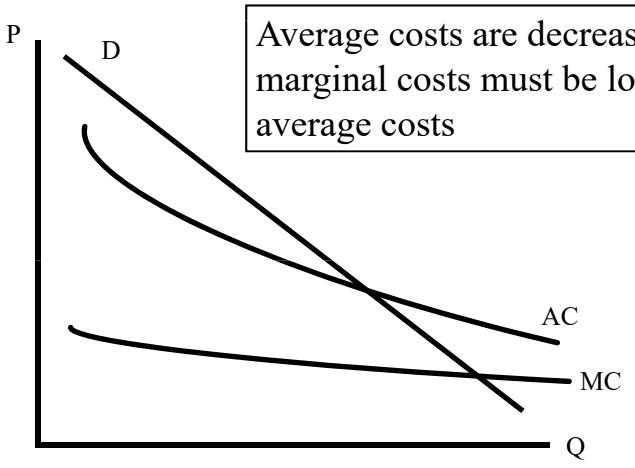
- Price - power, telecom (partly)
- Quantity - spectrum#, banks branches
- Entry & Exit - telecom, power, banking, insurance
- Quality - telecom, power etc.
- Investment – capacity expansion during license raj
- Access to Resources – mining rights for power (coal), Iron & Steel etc

How to ease Monopolistic Pressure (including regulated natural monopolies)?

- Allow / facilitate entry of more market players
- 'Control/influence' prices / quantity supplied
- Create incentives so that Monopolists emulates a competitive behaviour.

Economics of Natural Monopoly

Natural Monopoly: Cost Characteristics



Average costs are decreasing, so marginal costs must be lower than average costs

Natural Monopoly: Sub-additivity

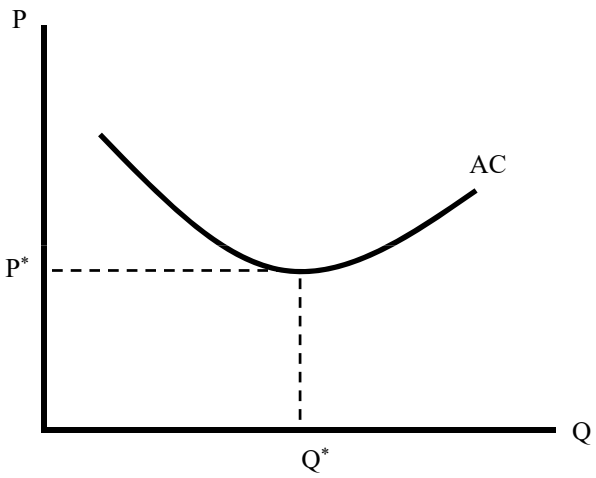
- If a single firm can produce a product or a group of products more cheaply than two or more firms, a natural monopoly is deemed to exist.
- Sub-additivity defines it more technically as,

  "If costs in an industry are sub-additive, a natural monopoly exists in an industry."

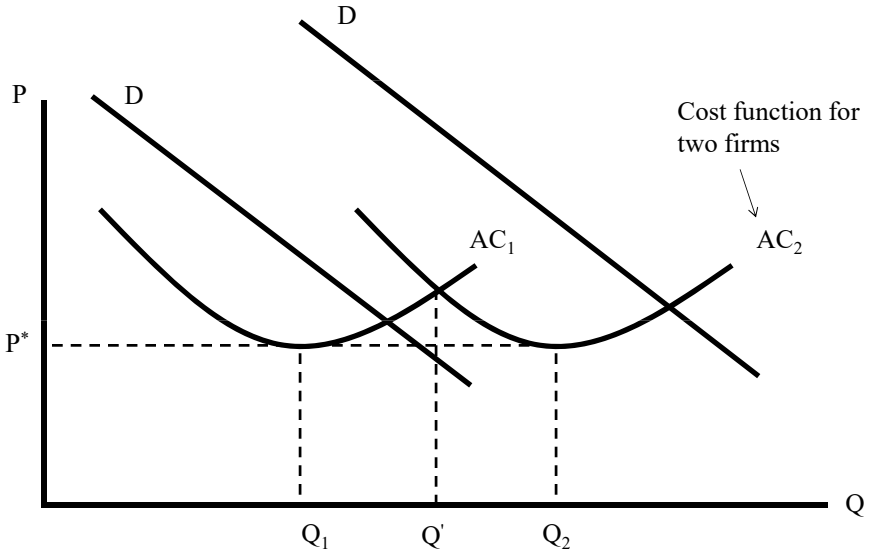
  If two firms produce outputs Q1 and Q2 respectively and their cost function is defined as c(.) , sub-additivity would exist if

  $c(q1+q2) < c(q1) + c(q2)$

Natural Monopoly: Sub-additivity



Natural Monopoly: Sub-additivity



Natural Monopoly: Sub-additivity

- Imp.: Note the difference between economies of scale and subadditivity. The later can exist even in the presence of this economies of scale In the previous figure, we can note that average cost associated with a single firm AC1 lies below AC2 even though the former exhibits this economies of scale for quantities more than's Q*.
- In a single product case, economies of scale is a sufficient condition for subadditivity.

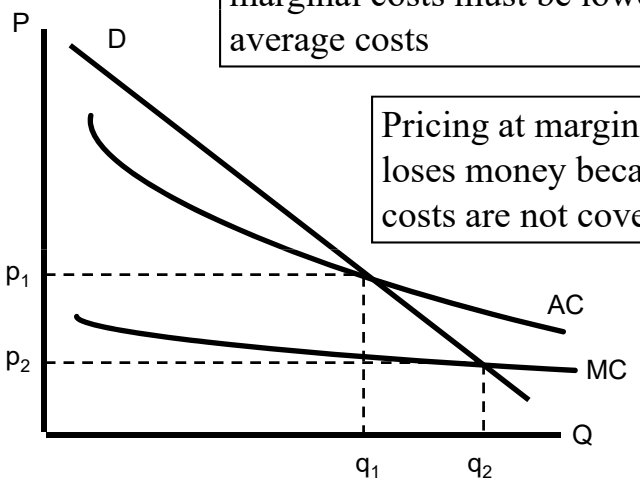
Pricing for Natural Monopoly

- MC Pricing
- AC Pricing
- Non-Linear Pricing
- Ramsey Pricing

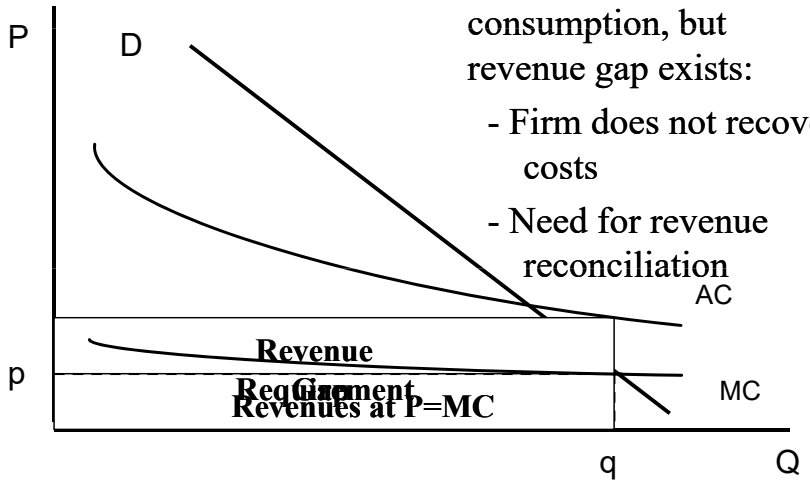
Natural Monopoly: MC < AC

Average costs are decreasing, so marginal costs must be lower than average costs

Pricing at marginal cost, firm loses money because average costs are not covered



Natural Monopoly: Revenue Gap



At P = MC, efficient consumption, but revenue gap exists:

- Firm does not recover all costs
- Need for revenue reconciliation

Marginal Cost Pricing

- Outcome has allocative efficiency.
- Weak incentive to reduce costs.
- Firm does not covers costs and makes losses.
- Use tax revenues or direct subsidy to firm to cover revenue shortfall?

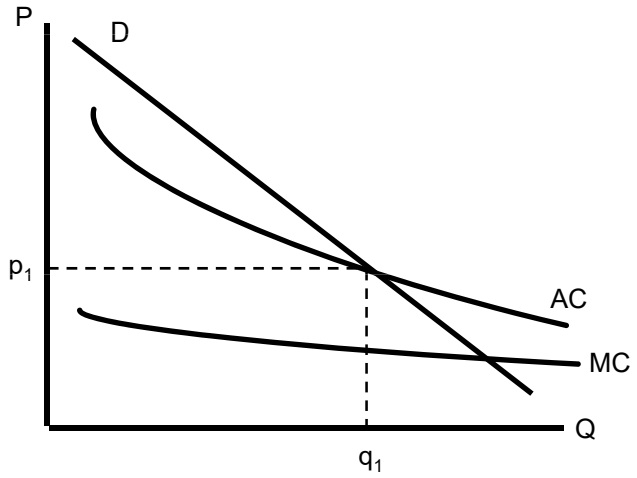
Issues with use of subsidy for bridging revenue gap

- Subsidy for bridging the revenues shortfall
  - Govt. need to raise taxes to fund the subsidy. Taxes are distortionary
  - Reduced incentive for cost reduction since the producer knows that revenue gap would be funded
  - Costs may exceed consumer benefits
  - Distributional issues

Average Cost Pricing

- Firm covers costs including opportunity cost of capital.
- Weak incentive to reduce costs since costs re covered.
- Does not require subsidy or distortionary taxes to cover revenue shortfall.

Average Cost Pricing



Average Cost Pricing (Contd.)

- Firm covers costs and earns economic profits.
- Failure of allocative efficiency. Less quantity and higher price that in MC pricing case (but lower P and higher Q than profit maximisation by the monopoly)
- Weak incentive to reduce costs.

Natural Monopoly: Non-Linear Pricing

- Also called Block Pricing
- Most basic form would be a two-part tariff
  $P = a + b\,Q$
  b is set equal to marginal cost
  a covers revenue shortfall due to MC pricing.

- If Σ a (across all consumers) = revenue shortfall to ensure economic profits, it ensures allocative efficiency and firm earns economic profits. It still lacks incentive to continuously reduce costs.

Designing Fixed part of Tariff

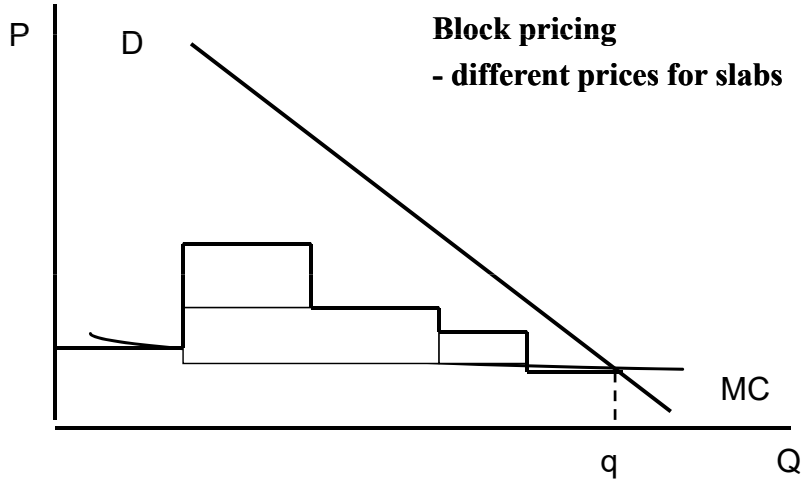
- Equal fixed cost to all customers (non-discriminatory but distributional issue)
- Hence, discriminatory fixed charge

Non-Linear Pricing

Declining Block Tariff

- Fixed Charge = 10
- Rs. 2 for first 100 units
- Rs. 1.5 for next 100 units
- Rs. 1 for next 100 units
- Write tariff schedule and draw diagram

Natural Monopoly: Declining Block Pricing



Ramsey Pricing

- When it is easy to identify the characteristics of users of a public service, or in the case of a multi-product monopoly.
- Ramsey prices ensure total cost is covered from total revenues, and that welfare losses are minimised.
- Suppose that price elasticity of distinct groups of users (say, domestic and commercial consumers) is known, and is different. The less elastic the demand, the higher the price that should be charged on efficiency grounds.
- Those with more alternatives, can switch to other services, will reduce demand in response to the higher price. Those with fewer choices would be charged more.
- Charging what the market will bear may not always be

Ramsey Pricing

- When it is easy to identify the characteristics of users of a public service, multi-part tariffs -- often called discriminatory prices -- may be useful in achieving efficiency.
- Suppose that price elasticity of distinct groups of users (say, domestic and commercial consumers) is known, and is different. The less elastic the demand, the higher the price that should be charged on efficiency grounds.
- Those with more alternatives, can switch to other services, will reduce demand in response to the higher price. Those with fewer choices would be charged more.
- Charging what the market will bear may not always be considered fair!

Ramsey Pricing (Contd.)

- For multi-product natural monopolist, MC pricing leads to losses. Pricing above MC it can cover this loss. Ramsey pricing rule relates this markup of price over MC to own price elasticity of demand
- Ramsey Pricing Rule

$(P_i - MC_i)/P_i = X/E_i$, i = 1, 2, …, N products,

Where, X - a constant, E_i - own price elasticity of demand

Thank You

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Selected Readings

- Anoop Singh, Tooraj Jamasb, Rabindra Nepal, and Michael Toman, Cross-Border Electricity Cooperation in South Asia, World Bank Policy Research Working Paper (PRWP), #WPS7328, 2015.
- Anoop Singh, Jyoti Parikh, K.K. Agrawal, Dipti Khare, Rajiv Ratna Panda and Pallavi Mohla, "Prospects for Regional Cooperation on Cross-Border Electricity Trade in South Asia", 2013, IRADe, New Delhi
- "Power Sector Reform in India: Current Issues and Prospects", Energy Policy, Elsevier, Volume 34, Issue 16, November 2006.
- "Towards a Competitive Market for Electricity and Consumer Choice in Indian Power Sector", Energy Policy Vol. 38 4196-4208, 2010. (Elsevier)
- "Analysing Efficiency of Electric Distribution Utilities in India: a Data Envelopment Analysis" (with Dilip Kumar Pandey), IAEE International Conference, Stockholm 19-23 June, 2011.

Selected Readings (Contd.)

- "Modelling Economic Efficiency of Renewable Energy Policies: A Multi-State Model For India", Accepted for World Renewable Energy Congress, 17-19 Oct. 2011, Bali, Indonesia. (with Sundeep Chowdary).
- "Economics, Regulation and Implementation Strategy for Renewable Energy Certificates in India" in India Infrastructure Report 2010, Oxford Univ. Press.
- "A Market for Renewable Energy Credits in the Indian Power Sector", Renewable and Sustainable Energy Review journal, Elsevier, 2009.
- "Economics of Iran-Pakistan-India Natural Gas Pipeline: Implications for Energy Security in India", Economic and Political Weekly, Vol. XLIII, No. 7 2008.

Courses, Workshops and Conferences

- Short Term Course "Challenges and Implementation Issues post Electricity Act 2003: Regulatory, Policy & Technical Solutions", 10-14 April, 2004
- International Conference on "Power Market Development in India: Reflections from International Experience", 19-21 April, 2005
- National Workshop on "Project Financing for Energy and Infrastructure Sector", April 19-22, 2007
- 2nd National Workshop on "Project Financing for Energy and Infrastructure Sector", April 24-27, 2008
- Capacity Building Programme for Officers of Electricity Regulatory Commissions, 30th June - 5th July, 2008
- 2nd Capacity Building Programme for Officers of Electricity Regulatory Commissions, 3-8 August, 2009

Courses, Workshops and Conferences (contd.)

- 3rd Capacity Building Programme for Officers of Electricity Regulatory Commissions, 23-28 August, 2010
- Energy Conclave 2010, 8-15 Jan. 2010
- 4th Capacity Building Programme for Officers of Electricity Regulatory Commissions, 18-23 July, 2011
- 5th Capacity Building Programme for Officers of Electricity Regulatory Commissions, IIT Kanpur and Bangkok, 18-23 Oct., 2012
- 6th Capacity Building Programme for Officers of Electricity Regulatory Commissions, IIT Kanpur and Bangkok ,9-15 Feb., 2014
- 7th & 8th Capacity Building Programme for Officers of Electricity Regulatory Commissions, IIT Kanpur and Singapore, Jan./Feb., 2015
- 9th Capacity Building Programme for Officers of Electricity Regulatory Commissions, IIT Kanpur and Singapore, 21-26 Nov, 2015
- IITK-IEX Training Program on Power Procurement Strategy and Power Exchanges, 20-22 April, 2015