Competition Models, Cost-Based Pricing

(Courcoubetis&Weber: Chapters 6.1-6.3, and 7)

Lecture Outline

- Competition models
  - Basic competition models
  - Price discrimination
  - Bundling
  - Customer lock-in
- Cost-based pricing
  - Terminology
  - Cost-based pricing
  - Flat-rate pricing
  - Pricing in practice

Basic Pricing Concepts

- Types of competition and market structure
  - Monopoly (single supplier, many buyers)
  - Perfect competition (many suppliers, many buyers)
  - Oligopoly (small number of suppliers, many buyers)
  - Other special types: monopsony, oligopsony, bilateral monopoly…
- Who sets the price? Basic cases:
  - *Pure monopolist* sets the price to maximize his supplier surplus (i.e. profit)
  - *Pure competition* drives the price toward marginal costs and thus maximizes consumer surplus (all players are *price takers*)
  - *Oligopoly* allows the choice of price and quantity which triggers pricing games and strategies!
  - *Regulator* sets the price to maximize social surplus / welfare (regulated monopoly)
- *Tatonnement* is the iterative process where the market equilibrium is achieved via price changes (assuming static utility and cost functions)
  - Ideal tatonnement rarely happens in the real world because
    - Utility and cost functions evolving too fast in innovative markets
    - Some forms of utility functions defying convergence
    - *Untruthful declarations* (i.e. misleading can be beneficial)
    - Finite capacity constraints causing delay

Pure monopoly

Basics

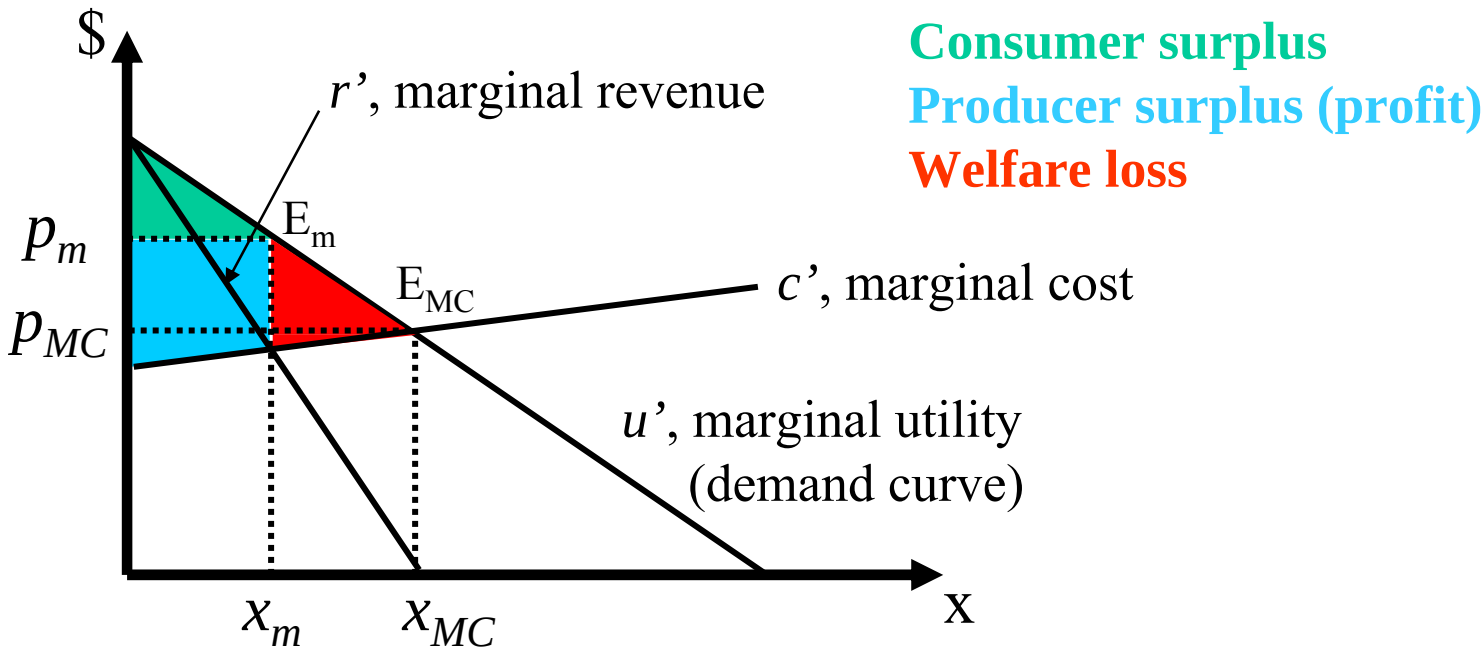
- Monopoly is a situation where a single supplier controls the quantity of production, and thus also the price
- Monopoly is likely when the market involves
  - demand-side economy of scale, i.e. positive network effects (the average utility per customer increases with larger customer base)
  - supply-side economy of scale (the average cost of production decreases with the quantity of good produced)
  - supply-side economy of scope (the average cost of production decreases with the number of different goods produced)
- *Natural monopoly* is a market consistently showing all the above-mentioned economies of scale
  - I.e. monopolist supplier can supply the aggregate output of several smaller suppliers at lower costs
  - Mathematically, a cost function for services x and y

    $c_{monopolist}(x+y) \leq c_{supplier1}(x) + c_{supplier2}(y)$

Pure monopoly

Profit maximization

- Monopolist's problem: maximize$_p$ $[\sum_j p_j x_j(p) - c(x)]$
- Profit is maximized when *marginal revenue* equals *marginal cost*
  - I.e. cost of producing one additional unit equals the revenues obtained from selling the unit
- Welfare (social surplus) would be maximized when price is set to marginal cost
  - Regulator likes to push the price toward *marginal cost*



Consumer surplus
Producer surplus (profit)
Welfare loss

Perfect competition

- Regulator may not be satisfied even on a welfare maximizing monopoly since innovation requires competition
- Under perfect competition
  - consumers maximize net benefit u(x) – px, at marginal utility = price
  - operators participate if, $py^* \geq F + c_v(y^*)$, where y^* is the optimal service volume, F is fixed cost, and c_v is variable unit costs
  - social surplus is maximized at *market clearance*, i.e. demand = supply
- Perfect competition may not be achieved due to
  - non-identical service offerings
  - limited visibility to prices of other players
  - high switching cost paid by customers for changing operators
- An example of high switching cost is the change of a phone number, which the regulator often solves via number portability

Price discrimination (1/2)

Types of price discrimination

- Supplier sells the same product/service at different prices
- 1st degree price discrimination (i.e. personalized pricing)
  - Operator maximizes profit per customer, prices user-specific $p_i = u_i$
  - Also called perfect price discrimination
  - All customer surplus turns into operator surplus
- 2nd degree price discrimination (i.e. versioning, quantity discrimination)
  - Operator posts a set of offers (e.g. high/low quality, volume discounts)
  - Customer self-selects the most suitable offer to maximize surplus
  - Optimal volume pricing holds the following properties
    - The highest demand customer chooses the version of lowest price per unit
    - Monopolist takes all surplus of lowest demand customers
    - The higher demand customers receive an informational rent
- 3rd degree price discrimination (i.e. market segmentation, group pricing)
  - Grouping based on pre-selection, e.g. students and seniors
  - Different segments have different price elasticities, $\varepsilon_i=(\Delta x/x_i)/(\Delta p/p_i)$, which enables different prices

Price discrimination (2/2)

Required conditions for price discrimination

- Producer must have some pricing power in order to charge differentiated prices
  - In theory, possible only for a monopolist (who has control over prices)
  - In practice, also possible in oligopolies and even in near perfect competition to some degree
- Producer must have some knowledge on consumer preferences
  - 1st degree: knowledge on individual customers' willingness to pay
  - 2nd degree: information on individual consumers is not available but different customers can be indirectly induced to reveal their preferences if different types of customers that exist are known
  - 3rd degree: information on the elasticity of demand in different markets or segments.
- Consumers cannot resell / trade commodities, i.e. no second-hand market
  - Otherwise e.g. people who paid a low price can resell the commodities to those who would have been willing to pay more

Bundling (1/3)

Service bundling and differentiation

- In *bundling*, a number of different products/services are offered as a single product, with a price that differs from the sum of the prices of individual products
  - Bundling is one form of versioning, and sometimes enables price discrimination
  - Bundling reduces dispersion in willingness to pay and thus enables greater revenue
- Operator can segment the market via service differentiation
  - Versions of service must not substitute each other
  - Operator must prevent harmful reselling (e.g. wholesale vs. retail)
  - Service differentiation based on transferred content (e.g. business/leisure) not easy for an operator
    - Operator not allowed to read user-created content
    - Technology-based differentiation difficult (e.g. IP vs. SMS)
    - Operator's charging can be by-passed (e.g. credit cards)

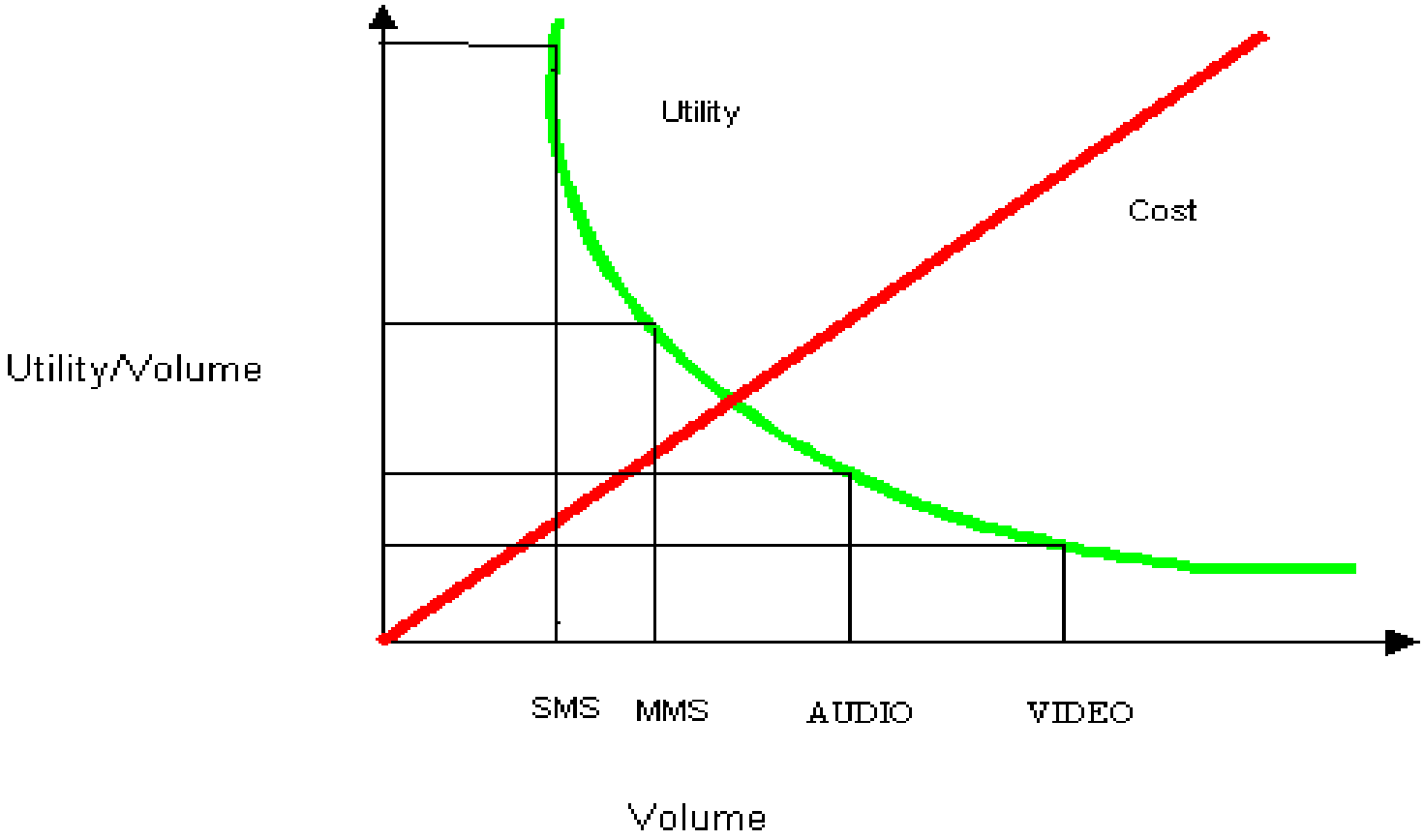
Bundling (2/3)

Vertical vs. horizontal bundling in GSM

- Vertical bundling
  - Bundling of access with content, handsets with subscriptions
  - For instance weather report over SMS
- Horizontal bundling
  - Bundling of access services (e.g. multiple radios, circuit vs. packet-switched, voice vs. data)
  - Bundling of vertically bundled services (e.g. weather report over SMS vs. WAP)
- Bundling enables
  - Cross-subsidies and service differentiation
  - Value-based pricing, i.e. flexible testing of subscriber's willingness-to-pay

Bundling (3/3)

Bundling and subsidies: roll-out of new services



- Cross-subsidies enable early roll-out of still non-profitable services
- Operator can also take risk of new handsets via handset subsidies

Customer Lock-In (1/3)

Concepts

- *Lock-in* (a.k.a. vendor / customer / proprietary lock-in) refers to the dependence of a customer on a provider
- Lock-in is proportional to *switching costs* (direct and indirect) caused by changing the provider
  - E.g. cost and pain of changing a phone number or email account
  - Service provider may inflate the real switching cost to obtain additional margins
- In practice, conditions of perfect competition may not be achieved because of customer lock-in
- Regulator keeps reducing the switching cost to promote competition and to cut prices (e.g. number portability)
- Effects of lock-in can be quantified by observing that service providers can obtain profits per customer equal to the switching cost!

Customer Lock-In (2/3)

Quantification

- Let service providers (*i* and *j*) have a monthly charge of *p* and a monthly variable cost of *c* per customer. In a competitive market and in the absence of switching cost the price would simply be $p = c$
- Now, at equilibrium, let it cost customers *s* to switch providers, let providers offer one-time discount *d* to attract new customers from other providers, and let *r* be the monthly interest rate

Price of staying with provider i equals the price of switching to provider j

(1) $p_i + p_i / r = p_j - d_j + s + p_j / r$

Provider j must be profitable if customers switch to him (present value of profits equals zero)

(2) $(p_j - c) - d_j + (p_j - c) / r = 0$

Conditions (1) and (2) imply

(3) $(p_i - c) + (p_i - c) / r = s$ *present value of a customer equals her switching cost*

or

(4) $p_i = c + sr / (1 + r)$ *price equals marginal cost plus mark-up on switching cost*

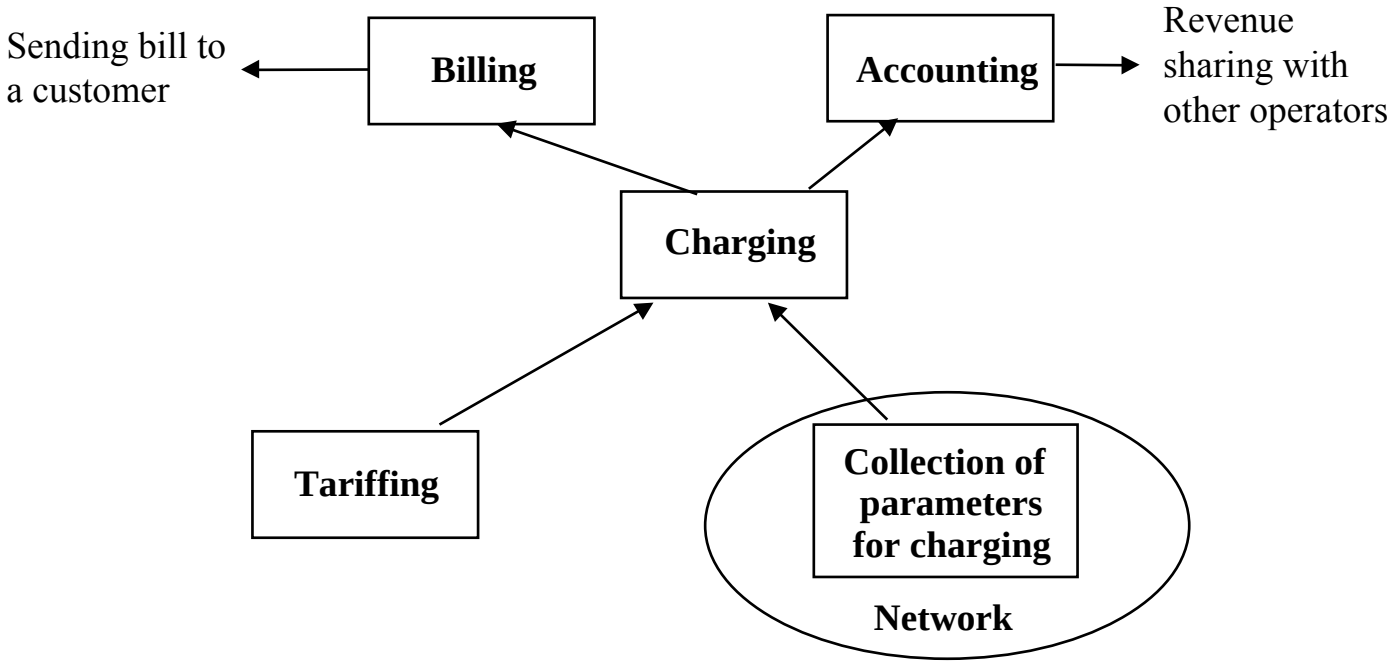
Source: Courcoubetis et al, 2003

Price, tariff, and charges

- *Charge* is the amount that is billed for a service
- *Price* is the amount of money associated with one unit of usage
- *Tariff* refers to the structure of prices and charges
- Telecom tariffs are typically non-linear and two-part
- Two-part tariffs are of the form $\boldsymbol{a + bx}$
  - *a* is fixed charge (e.g. 10€ monthly GPRS access charge)
  - *b* is unit price (e.g. 1€ price per GPRS megabyte)
  - *x* is quantity (e.g. number of GPRS megabytes per month)
- Two-part tariff reflects the operator's cost structure, i.e. fixed vs. variable costs
- How to set optimal tariffs?
  - High fixed charge discourages small customers
  - High unit price discourages large customers

Tariffing Activities

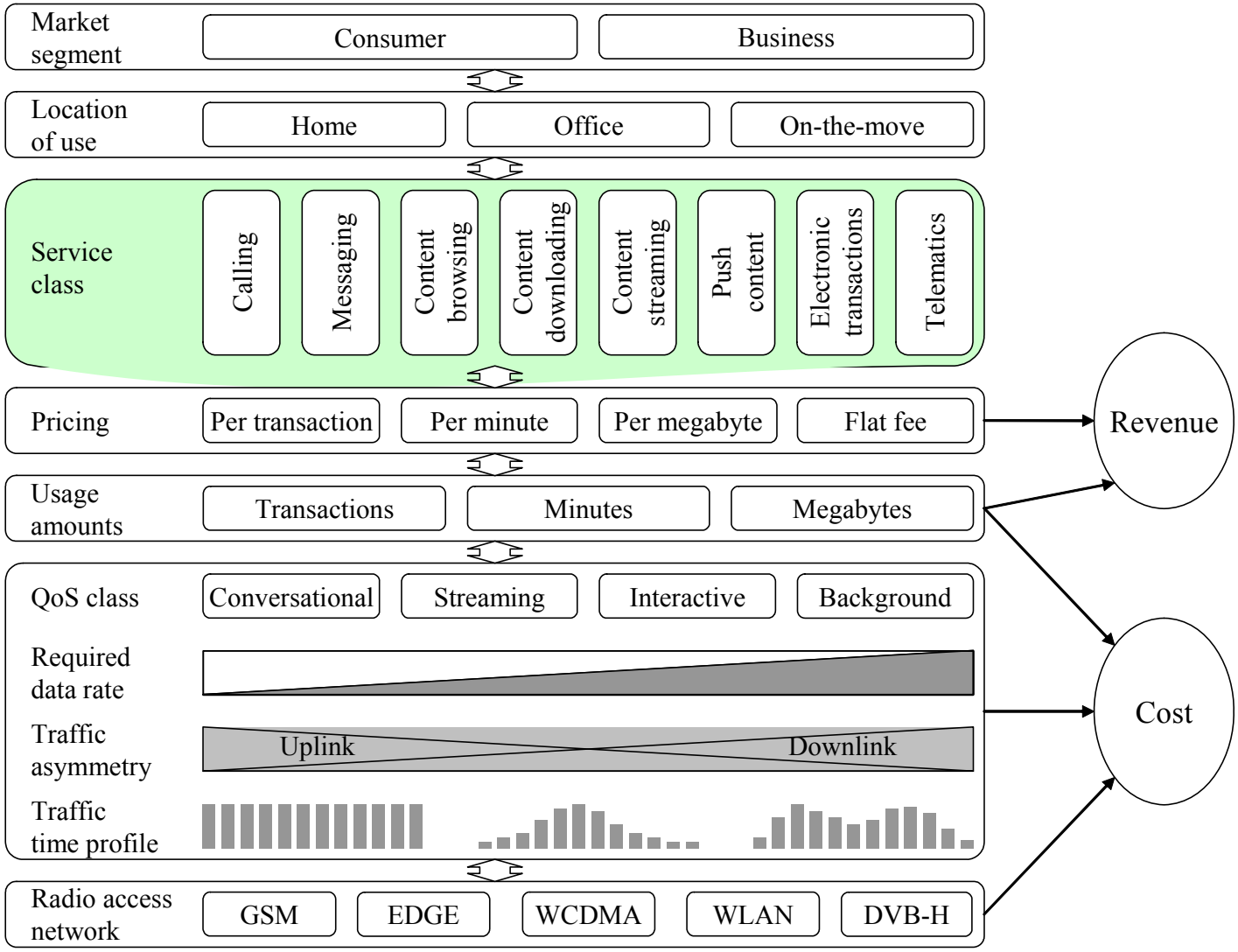
Data Flows



- Charging combines the resource usage data with tariffing data
- Tariffing (price setting) is a strategic sales activity
  Charging and billing are operational engineering

Service Classification

Technical Pricing Parameters of Mobile Services



Source: ECOSYS, 2005

Cost-based pricing (1/3)

Motivation

- Marginal cost pricing maximizes welfare but causes problems to operators
  - Exclusion of fixed costs
  - Prices difficult to compute
  - Prices can be close to zero or infinity
- Operator's cost recovery can be supported by weighting the social surplus function in favor of operators (Ramsay pricing)
- Burden of fixed costs can also be reduced by cutting capacity needs via peak-load pricing
  - Traffic load is moved from busy hour to other time periods
  - Traffic loss vs. capacity savings?

Cost-based pricing (2/3)

”Fair” prices

- Cost-based pricing assumes that costs are shared in a ”fair” way among customers
  - *sustainable prices* reflect actual costs and discourage inefficient ’hit-and-run’ competition
  - In *subsidy-free prices* no customer is subsidizing the cost of producing the service to other customers (reduces churn)
- Conditions for subsidy-free pricing are
  - charge made to any subset T of customers N is no more than the stand-alone cost of providing services to those customers

    $$\sum_{j \in T} c_j \leq c(T), \text{ for all } T \subseteq N$$

  - charge made to any subset of customers is at least the incremental cost of providing services to those customers

    $$\sum_{j \in T} c_j \geq c(N) - c(N \setminus T), \text{ for all } T \subseteq N$$

  - assuming a set of n customers $N = \{1,2\ldots,n\}$, subadditive cost function, charges c_j, cost recovery $\sum_{j \in N} c_j = c(N)$

Cost-based pricing (3/3)

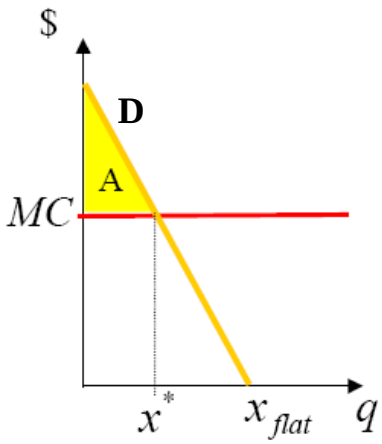
Implemention issues

- Problem of knowing the real costs per service
  - Future is often less known than history (plus accounting delays)
  - Cost structures keep changing because of technology evolution
  - Common (non-service-specific) costs dominate
- Solutions for allocating costs to services
  - Top-down approaches (based on historic costs)
    - Fully Distributed Costs, FDC (flat, coefficients, ad hoc?)
    - Activity-Based Costing (e.g. hierarchical process)
  - Bottom-up approaches (based on current costs)
    - Efficient Component Pricing Rule, ECPR
    - Long-Run Incremental Cost, LRIC(+)
- LRIC+ is complex, but favored by regulators because of subsidy-free prices, legacy-free costs, and the right competitive signals to the market (fairness toward incumbents?)

Flat-rate pricing

- Total charge a customer pays for a service contract is fixed
- Price is set a priori, but the real cost can only be known a posteriori
  - E.g. broadband Internet access
- Pros
  - Simple and cheap to implement for operators
  - Predictable to customers
- Cons
  - Waste of resources → high social cost (obs. cost savings!)
  - Unfair, as light users subsidize heavy users (only if customers know and care!)
- How to improve flat-rate?
  - Divide flat-rates in intervals, e.g. ADSL with multiple speeds
  - Add usage-based tariff for extra usage, e.g. GPRS block pricing

Waste in flat-rate pricing



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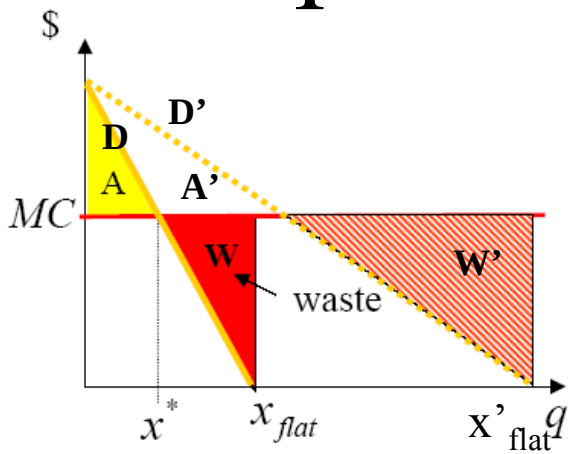

Flat price (p=0)

- Social welfare is maximized in marginal cost pricing (left figure), social welfare = A
- In flat rate pricing (right figure)
  - Consumers observe the marginal price (p = 0) → no incentive to reduce consumption → maximum consumption (i.e. overconsumption)
  - Producer still has variable production costs MC · x_{flat}
  - W is waste, and total social welfare is A – W
  - If demand grows (D → D') so does the waste (W')
- Fixing the flat rate based on an average consumer does not work either
  - People who want to consume a lower amount of service don't participate at all → average price goes up and up → only the high-consuming consumers participate → smaller base of consumers, lower total revenue

Access vs. backbone transport

- Tough competition in backbone
  - Capacity-based wholesale pricing dominates
  - Service differentiation difficult
  - Prices close to marginal cost due to competition
  - Marginal cost of new traffic getting close to zero because the excess fiber capacity becomes sunk cost
- Monopolies and oligopolistic competition in access
  - Operators capable of bundling and differentiating
  - Evolving technology maintains dynamics in pricing
  - Regulators pushing cost-based pricing and LRIC+

Pricing in practice?

Systematic use of pricing theory?

OR

Reactive innovation by trial and error?

Yes, both, continuously!