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*
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.

\[
\text{Price of staying with provider } i \text{ equals the price of switching to provider } j \\
(1) \quad p_i + \frac{p_i}{r} = p_j - d_j + s + \frac{p_j}{r} \\
\text{Provider } j \text{ must be profitable if customers switch to him (present value of profits equals zero)} \\
(2) \quad (p_j - c) - d_j + \frac{(p_j - c)}{r} = 0 \\
\text{Conditions (1) and (2) imply} \\
(3) \quad (p_i - c) + \frac{(p_i - c)}{r} = s \quad \text{present value of a customer equals her switching cost} \\
\text{or} \\
(4) \quad p_i = c + \frac{sr}{1 + r} \quad \text{price equals marginal cost plus mark-up on switching cost}
\]

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 $a + bx$
  - $a$ 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

<table>
<thead>
<tr>
<th>Market segment</th>
<th>Consumer</th>
<th>Business</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location of use</td>
<td>Home</td>
<td>Office</td>
</tr>
<tr>
<td>Service class</td>
<td>Calling</td>
<td>Messaging</td>
</tr>
<tr>
<td>Pricing</td>
<td>Per transaction</td>
<td>Per minute</td>
</tr>
<tr>
<td>Usage amounts</td>
<td>Transactions</td>
<td>Minutes</td>
</tr>
<tr>
<td>QoS class</td>
<td>Conversational</td>
<td>Streaming</td>
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<tr>
<td>Required data rate</td>
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<tr>
<td>Traffic asymmetry</td>
<td>Uplink</td>
<td>Downlink</td>
</tr>
<tr>
<td>Traffic time profile</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radio access network</td>
<td>GSM</td>
<td>EDGE</td>
</tr>
</tbody>
</table>

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 \( N = \{1,2...,n\} \), subadditive cost function, charges \( c_j \), cost recovery \( \sum_{j \in N} c_j = c(N) \)
Cost-based pricing (3/3)

Implementation 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 $\rightarrow$ 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

$p = MC$

• 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 $MC \cdot x_{\text{flat}}$
  – W is waste, and total social welfare is $A - W$
  – If demand grows ($D \rightarrow D'$) 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!