Part II:
The economics of information technology

1. Introduction
2. The Internet Boom
3. Pricing strategies
4. Switching costs an lock-in
5. Network Effect
6. Standards
7. Topics
   7.1. Linux versus Windows
   7.2. Napster
   7.3. The economics of Piracy
References

- **Books**
  - *The Economics of Information Technology: An Introduction* (Raffaele Mattioli Lectures) by Hal Varian, 2004;
  - (Farrell and Shapiro, 2004)
  - Information rules, Shapiro and Varian, 1999

- **Papers**
  - Why Napster is right, Boldrin and Levine, 2002
  - “A model of Piracy” by Bae and Choi, 2003; “Copying and software pricing” by Crampes and Laffont, 2002
1 Introduction

• The study of the economics of IT is not the study of a new economics.

• But rather the study of specific effects (network effects, switching costs,...) studied in traditional IO courses.

• High-tech industries are subject to the same market forces as every other industries.

• For instance, forces at work in network industries in the 1990s are similar to those in the telephone and wireless industries in the 1890s.

• One of the characteristics of the IT industry is the cost structure
  – constant and possibly high fixed costs,
  – zero or very low marginal costs.

• Common in pure information goods and also physical goods.

• Example: chips. Fabrication plant costs several billion of $, cost to produce a chip: only few $. 

3
• Competitive strategies used by high tech companies, such as
  – personalized pricing (price discrimination),
  – lock-in,
  – exploitation of network effects,
  – adoption of uniform compatible standards.

• For instance: Microsoft uses price discrimination, lock-in and exploitation of network effects.

• IPR influence competition strategy in the information technology sector.
  – Computer software companies: Microsoft uses copyrights, patent and secrecy to protect its software programs.
  – IT firms such as IBM, Intel, Hewlett-Packard and Motorola receive hundred if not thousands of patents each year. They use their patent portfolio
    * offensively (to keep out competitors)
    * defensively (to negotiate cross licensing)
2 The Internet boom

- Rapid boom in the late 1990s
- Technologies can be combined and recombined to create new products.
- Combinatorial innovation is one of the important reasons why inventions appear in waves or clusters (Schumpeter (1934)).
- Possible explanations of clusters of innovation:
  - demand side (Schumpeter)
  - supply side
  - development of complements
- Why the Internet revolution took only few years?
  - minor technological development,
  - component parts are different from the mechanical and electrical devices
    * ideas
    * standards specification
* protocols
* programming language
* software

- Lack of physical constraints (no delay to manufacturer, no shipping costs, no inventory problems)

- The biggest capital investment: human capital.
- What now?
  - Period of consolidation
  - Innovations exist, they still have to be fully incorporated into organizational work practices.
3 Pricing strategies

- Price discrimination (PD) due to
  - high fixed cost, low MC ⇒ market power, $p > MC$
  - observation and analysis of consumer behavior ⇒ differentiation

Different pricing strategies

- First-degree PD
- Second-degree PD
- Third-degree PD
- PD based on purchase history
- Search good
- Bundling
3.1 First-degree PD

- “Mass customization” or “personalization”

- Examples:
  - consumers can buy personally configured computer from DELL,
  - a computer customized blue jeans from Levi’s.

- Monopoly first-degree PD: each consumer pays his reservation price; Monopoly captures entire surplus.

- But there is competition...

- First-degree PD and product differentiation in competitive environment (Ulph and Vulkan, 2000, 2001)

- Consumers differ with respect to their most preferred products

- Firms choose where to locate in product space; how much to charge to each consumers

- Full information
• Findings:
  
  – 2 effects

    1. enhanced surplus extraction effect
    2. intensified competition effect

  – If consumer tastes are not too different, the second effect dominates the first one: firms are worse off, consumers better off.

• However, some firms may have better information than others.

• Personalized pricing raises privacy issues.
3.2 Second degree PD

- Also called “product line pricing,” or “market segmentation,” “versioning”

- Everyone faces the same menu of prices for a set of related product.

- Sellers use their knowledge of the distribution of consumer tastes to design a product line.

- Example of information goods sold in product lines
  - Books: hardback, paperback
  - Movies: theater, airplane, on tape, on DVD, TV
  - Newspaper: on-line or paper.

- IT is helpful in
  - collecting information about consumers
  - producing the different version
• There is a self-selection problem; in designing a product the company compete against itself.

• PD adopted in IT industry
  – Microsoft sells different versions of its operating system, and application software
  – DVDs: “standard” versus “collectors edition”
3.3 Third degree PD

- Sell at different prices to different groups
- Monopoly third-degree PD
- Competitive case: Armstrong and Vickers (2001) survey this literature
  - same taste, and fixed cost of serving each consumer, competitive third-degree PD makes consumers better off.
  - Because competition forces firms to maximize consumer utility and PD gives them additional flexibility in dealing with fixed costs.
  - heterogenous consumers: not clear.
    * CS is reduced,
    * profits are enhanced,
    * welfare can decrease.
3.4 PD based on purchase history

- Monopolist can PD between old and new consumers by offering upgrades (Fudenberg and Tirole (1998))

- Even if the monopolist can make offers based on previous purchase history, it is never profitable to do it. (Acquisti and Varian (2001))
  - 2 types of consumers: high value and low value
  - monopolist can commit to a price plan

- However, if monopolist can offer an enhanced service (recommendations based on purchase history), it may be optimal to condition prices on earlier behavior and extract some of the value from this service.
3.5 Search

• The Internet lowers search costs

• Shopping agents (Yahoo, BizRate...): easy price comparisons

• What happens when some consumers use shopping agents and others shop at random? (Baye and Morgan (2001))

• Sellers use mixed strategies and randomize the prices they charge.
  – sometimes charge low price to compete for searchers
  – still charge on average high price to non-searchers
3.6 Bundling

- Sell two or more distinct goods together for a single price.
- MC of adding an extra good is negligible
- 2 effects:
  - reduced dispersion of willingness to pay (PD)
  - increased barriers to entry

- Example: software producer sells both
  - Word processor (W)
  - Spreadsheet (S)

- 2 types of consumers with different willingness to pay

<table>
<thead>
<tr>
<th></th>
<th>Consumer 1</th>
<th>Consumer 2</th>
<th>Uniform</th>
<th>Bundling</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>$120</td>
<td>$100</td>
<td>$100</td>
<td>$220 for W+S</td>
</tr>
<tr>
<td>S</td>
<td>$100</td>
<td>$120</td>
<td>$100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( \Pi = $400 )</td>
</tr>
</tbody>
</table>

- Bundling reduces the dispersion of willingness to pay.
• If many consumers, many different willingness to pay:
  • Bundling allows the monopoly to reach
    – many of those who value both products highly
    – some who only value one product highly.

• Entry becomes less attractive as residual demand is reduced.
4 Switching costs and lock-in

• Switch from Windows to Linux can be very costly
  – change document formats
  – application software
  – Invest time and effort in learning the new operating environment.

• High switching costs in high tech industries

• Lock-in: it is too costly to switch

• Example: cheap printer and very expensive cartridge

• Switching cost: purchase of a new printer

Model Klemperer (1995)

- 2 periods
- \( n \) consumers
- Each consumer is willing to pay \( v \) per period to buy a nondurable good
- 2 producers
- Same MC: \( c \)
- Non-commitment
- Switching cost: \( s \)
- Assumption: \( v \geq c \) but \( v - s < c \) (it pays each consumer to buy the good but not to switch)

- What are the price at the equilibrium?

- At \( t = 2 \)
  - Unique Nash Equilibrium: each firm sets \( p_2^* = v \)
  - Profit \( \Pi_2 = v - c \)
  - The seller can extract full monopoly profit second period since consumers are locked-in
• At $t = 1$
  
  – Each firm would be willing to pay up to $v - c$ to get a consumer
  
  – Bertrand competition pushes profit to 0, $\Pi = p_1 - c + v - c = 0$
  
  $p_1^* = 2c - v$

• The higher the second 2d period monopoly payoff ($v - c$), the smaller the 1st period price.

• The first period price is lower because of the second period lock-in.

• First period prices are lower due to switching costs because sellers cannot commit on future prices.

• In case of commitment: one-period model, Bertrand results, $p^* = 2c$. 
5 Network effects

• A good exhibits (direct) network effects if the demand for the good depends on how many other people purchase it.

• Example: e-mail

• Indirect network effect: the more people have DVDs, the more DVD-readable content will be provided. Indirectly, the DVD purchase of someone enhances the value of someone else DVD player.

• Indirect network effects are common in high tech products: the demand for an infrastructure depends on the availability of applications and vice versa.

• Network externalities in oligopoly models (Katz and Shapiro, 1985, 1986, 1992)

• Review of litterature (Katz and Shapiro, 1994; Economides, 1996)

• When network effects are present, early adopters may value the network good less than subsequent adopters. Sellers should offer them a lower price (penetration pricing). PD
6 Standards

• The value of a network depends on its size, then standardization becomes important.

• Standards formation (survey, Besen and Farrell, 1994)

• 2 incompatible standards: Sony Betamax and VHS technologies for videotape.

• These technologies exhibit indirect network effects.

• 3 forms of competition in standards setting
  
  – standards war - firms compete to determine the standard
  
  – standards negotiation - both firms want a standard, disagree on which one
  
  – standards leader - one is a leader with a standard, the other wants to interoperate with the existing standard.
Standards war

Common tactics

• penetration pricing to built an early lead

• building alliances with suppliers of complementary products

• expectations management such as product pre-announcement

• commitment to low prices in the future (e.g., Microsoft announced that Internet explorer will be always free)

Standards negotiations

• Each player prefers a standard to no standard, but each prefers its own standard (Battle of the Sexes)

• The outcome of the negotiation depends on the threat point: what would happen is negotiation fails.

Standards leader

• Large established firm want to maintain a proprietary standard
7 Topic 1: Linux versus Windows

“Dynamic Mixed duopoly: a Model motivated by Linux versus Windows” by Casadesus-Masanell and Ghemawat)

• Mixed duopoly:
  – not-for profit competitor (Open source Linux)
  – for-profit competitor (Microsoft)

• Their model captures the most important features of the Linux-Windows competition battle:
  – faster demand-side learning on the part of Linux;
  – initial installed base advantage for Windows.

• Initial intuition: network effects and demand-side learning would result in Linux forcing Windows out.

• However they do not find that.

• Main result: in absence of cost asymmetries and as long as Windows has a first mover advantage (a large installed base at time zero) Linux never displaces Windows of its leadership position.
• From social viewpoint, a monopoly with Linux is better for society than a Windows monopoly.

• It is ambiguous whether a duopoly Linux-Windows is better than a Windows monopoly.

• There is a trade-off:
  – with duopoly more people use PCs because prices are lower and it raises welfare.
  – but with a duopoly, no operating system ends up exploiting fully its potential because developers’ efforts are reduced.

• However, with a monopoly, the efforts to develop new software and improve a platform are directed towards one system which can be better for society.
Sketch of the model

- Mixed duopoly: $L$ (Linux) and $W$ (Windows)
- demand-side learning for both OS (operating system)
- commitment for $L$ to price at 0
- Strategic but non-discriminatory pricing by $W$
- In each period $t$ a new cohort of potential users enters the market;
- Size of the cohort is 1
- $y_i(t)$ cumulative market share of OS $i = W, L$ at $t$
- $q(\tau)$: portion of consumers in time $\tau$’s cohort who buys $W$

\[
y_W(t) = \int_0^t q(\tau)d\tau \\
y_L(t) = \int_0^t (1 - q(\tau))d\tau
\]
• Every consumer in each cohort
  – either buys $W$
  – or download $L$ for free

• $y(t) \equiv y_W(t) − sy_L(t)$ where
  – $s > 1 (< 1)$, increase in $y_L$ has more (less) of a positive impact on perceived quality of $L$ than the negative impact of a comparable impact of $y_W$.

• $\alpha_i(y(t))$: OS’s technological trajectory (exogenously given), but introduced dynamics in competition.

• Linear demand function; $i$’ value to consumers

$$\alpha_i(y(t))(1 − q)$$

where $q \in [0, 1]$

• $\frac{\partial \alpha_i}{\partial y_i} > 0$ and $\frac{\partial \alpha_i}{\partial y_{-i}} < 0$

• + assumptions
Monopoly (Microsoft)

- MC of producing an extra copy of $W$ is 0
- Program is

$$\begin{align*}
\underset{p(t)}{\text{Max}} & \int_0^\infty e^{-rt} q(t) p(t) dt \\
\text{s.t.} & \quad \dot{y}_w = q(t) \\
& \quad p(t) = \alpha_W(y(t))(1 - q(t)) \\
& \quad p(t) > 0
\end{align*}$$

- Findings:
  - As $t \to \infty$, $p(t) \to \frac{\alpha_W}{2}$
  - As $t \to \infty$, $\alpha_W(y(t)) \to \overline{\alpha}_W$

- where by assumption $\lim \alpha_i(y) = \overline{\alpha}_W < \infty$: OS's value is finite even if everyone uses the OS. (i.e., technological trajectories are bounded)
Duopoly (W and L)

- W is sold at price $p$

- There exists an indifferent consumer

$$\alpha_W(y(t))(1 - q) - p = \alpha_L(y(t))(1 - q)$$

$$\Rightarrow p = \beta(y)(1 - q)$$

where

$$\beta(y) = \alpha_W(y(t)) - \alpha_L(y(t))$$

value difference between $W$ and $L$

- Consumers are myopic in each cohort: they buy OS that is most valuable to them

- A: At $t = 0$, $W$ is perceived as more valuable than $L$
• Program of $W$

\[
\max_{p(t)} \int_0^\infty e^{-rt} q(t)p(t)dt \\
\text{s.t.} \quad \dot{y} = q(t) - s(1 - q(t)) \\
p(t) = \beta(y(t))(1 - q(t)) \\
\beta(y(0)) > 0 \\
p(t) > 0
\]

• Findings:
  – $W$ and $L$ coexist in the LR, steady state equilibrium as $s > 1$.
  – When $s \leq 1$, $W$ pushes $L$ out of the market.

• $W$ is never pushed out, regardless of
  – $s$: speed of demand side learning
  – $\alpha_W - \alpha_L$: difference in potential maximum values
  – market share at $t = 0$
• Without $W$’s forward looking pricing strategy, $W$ would be replaced by $L$

• Therefore, it is $W$’s strategy that generates the result (and not switching cost)

• However, with MC for $W$, $L$ could force $W$ out of the market if $L$’s demand side learning $s$ is large enough.
8 Topic 2: The Napster case (music industry)


• What is the Napster case?

Major recording companies filed a lawsuit for contributory infringement against Napster. Napster was accused by RIAA of having launched a service that enables and facilitates piracy of music.

• Napster has built a system that allows users who log onto Napster’s servers to obtain infringing MP3 music files that are stored on the computers of other users who are connected to the Napster system at the same time.

• Napster provides advanced search capabilities, as well as direct hyperlinks to the MP3 files housed on its users’ computers.

• Is there a valid economic rationale for preventing distribution of music bought by some consumers?
• They are against IP and they provide argument in favor of removing any kinds of IPR.

• Music industry argues that
  – downloading music is a theft
  – reduce incentives to create music

• The music industry would like to prevent consumers from further distributing the music.

• Why consumers cannot sell on the Internet the music they have purchased?

• Production of music involves a fixed cost.
• But it is a sunk cost: at the time the CD is produced and the music is sold, the cost of writing / playing it the first time cannot be recovered.

• No economic rationale for giving monopoly power to cover sunk costs.

• A market in which original producers compete directly with the buyers could work.

• The first CDs would be sold at a high price. Few buyers have a high willingness to pay.
• Then the price will decrease.
• The profit sufficient to cover the production cost will have been earned.
9  Topic 3: The economics of Piracy (software industry)

“A model of Piracy” by Bae and Choi, 2003

• What are the short run effects of piracy in software usage and the long run effects on development incentives?

• There are **two types of costs associated to piracy:**
  
  – reproduction costs (identical for all consumers)
  
  – degradation costs (depends on the valuation for the original good of the consumers).

• Findings: the effects of piracy depend crucially in the nature of piracy costs.

• Model of self-selection with heterogenous consumers who choose among three options
  
  – the use of legal purchased copy
  
  – the use of illegal copy
  
  – no consumption.
• How the threat of piracy constrains the pricing behavior of the monopolist?

• What are the effects of an increase in the 2 different costs as change in IPR.

• Findings: with the threat of piracy, the monopolist’s price is lowered, and usage for an authorized copy is increased in both regimes.

• If copyright regime increases the constant reproduction cost, 2 opposite effects in the short run: positive demand shift and negative total usage change. It can increase or decrease the welfare in SR.

• However if copyright regime increases the degradation rate, it decreases the ex post efficiency.
“Copying and software pricing” by Crampes and Laffont, 2002

- Analyze of the effects of piracy on the pricing policy of software publisher.

- What are the consequences of cost randomness in the decision to use illegal packages of software and on the risk aversion of users?

- Contrary to the literature, they neglect the network externalities aspect and recognize the risk features of the illegal use of software.

- They assume that the cost of illegal acquisition of software is a random exogenous variable (depends on the control process used by the software publishers and on the magnitude of fines imposed by courts).

- Finding: piracy can have positive social effects in the short run.

- However piracy is detrimental in the long run because it limits the potential development of new products.