Economics and the Internet

Hal Varian
Jeff MacKie-Mason

http://gopher.econ.lsa.umich.edu
University of Michigan

Outline of talk

- Pricing transport
- Pricing content
- Network externalities
- Intellectual property

Pricing transport

- IP has one quality of service
- Will probably want multiple QoS in future networks
  1) applications (e.g., point to point video)
  2) users (e.g., financial markets)

Incentive problem

If all qualities cost the same...why not choose the best?

- how do you get applications to truthfully reveal their requirements?
- economics jargon: how do you make QoS "incentive compatible"?

One answer: pricing

- quotas
- rebates
- dollars: generate revenues for expansion

Different QoS

- Multiple networks with different QoS
  1) voice, video, data, etc on different networks
  2) several lines to the home
- One network with different prices for different QoS
  1) probably has a cost advantage
  2) but may require regulation (natural monopoly)
  3) if a network supports 2 way video, ASCII is free

Congestion

Congestion is a kind of QoS

Examples

- Web/ftp sites
- Europe (T1 backbone) and transAtlantic links
- NAPs and other traffic exchange points

May have to implement pricing to control congestion

- settlements at NAPs?
- New Zealand experience

Pricing mechanisms for IP: 1

Bohn, Braun, Claffy and Wolff: "Mitigating the coming Internet crunch"

- use precedence fields of IP header
- higher precedences serviced first
- have quota of precedence points
- payment depends on level of priority

Pricing mechanisms for IP: 2

MacKie-Mason and Varian: "smart markets"

- use precedence field of IP header
- router establishes cutoff precedence
- precedences higher than cutoff are admitted, lower ones dropped (or buffered)
- everyone admitted pays *cutoff price*
- this turns out to be incentive compatible
- basic idea: price should depend on state of network

Pricing mechanisms for IP: 3

- IPv6: dropable/expendable packets
- ATM: various proposals

Pricing is a lot easier with a connection oriented protocol

- can plan QoS for session
- exchange billing/accounting info in setup

  with IP, this info has to be in every packet

How big would prices be?

NFSNET backbone costs about $\$10^6$ per month

- per packet

  carries 60,000 x 10^6 packets (5% utilization)

  cost per packet = 1/600 cents
- per user

  10 million users of NSFNET?

  10 cents per month per user
- but video could be 10^3 as much = $100 per month

Billing and accounting

"80% of the cost of a telephone call is billing cost"

- fixed cost, incremental/marginal cost, and total cost
- 100% of the *incremental* cost of an off-peak call is billing cost
- part of *incremental* cost of on-peak call is billing
- average *incremental* cost is probably 50-80%
- but billing as share of *total* cost is about 6%

Distributed accounting

- but IP and telephony are different in many ways
- centralized telephone billing
- stamps and postage machines
- digicash and digistamps

  1) easy to do with secure physical device

  2) is there a software only solution?

Summary

- probably need some form of pricing to support different QoS and congestion management
- congestion problems may occur sooner rather than later
- technological progress *may* bail us out but ...
  1) technological progress increases both supply and demand for bandwidth
  2) better to think about this carefully now
  3) room for creative thought on pricing, billing, accounting

Pricing content

Information goods
- software
- movies
- games
- databases

Cost structure
- high fixed development costs
- zero incremental cost

Industry structure

- Difficult to sustain a competitive market
- Likely result is oligopoly/monopoly
- Price war problem
  1) airlines
  2) software
  3) telecom?
- Highly competitive now *because* of eventual oligopoly

Examples of pricing

Consider some examples of pricing problem
- single provider
- high fixed costs, 0 incremental costs

Example 1:

Person A: willing to pay $5 for book

Person B: willing to pay $3 for book

cost of book = $7 fixed cost, 0 variable cost

Observations about example 1

A wtp $5, B wtp $3, total cost=$7

- efficient to produce book
- can't recover costs at any uniform price
- can recover costs with price discrimination

Example 2

A wtp $8, B wtp $3, total cost=$7

- welfare max => A and B both get books
- uniform price + cost recovery => only A gets book
- price discrimination => both get books

Example 3

A wtp $20, B wtp $8, total cost=$7

- uniform price + profit max =>
  only A gets book
  even though B is wtp total cost of production!
- price discrimination =>
  both get books

Conclusions

Generally want to have price discrimination

- for cost recovery
- for profit maximization

Dimensions on which to discriminate

- want something correlated with WTP
- examples
  who you are: education, business, big user, off-peak, subscriber, foreigner
  what you want: immediacy, size, part of document
  quality: screen res, print res, ASCII, formatted, structured data

Complexity of pricing

airlines pricing
- use travel agents

information pricing
- use information agents?
- nature of the good + lower transactions cost=>return to negotiation/bargaining
- security issues: agents may know too much!

Price discrimination

Self selection problem

1) want to charge users with high WTP more

2) constrained by fact that they can choose product meant for low WTP users

3) airlines

a) business travel: high WTP

b) tourist travel: low WTP

c) airline solution: Saturday night stayover

Observations

- Supplier will want to degrade quality/quantity
  examples: student versions of software, 486SX, IBM LaserPrinterE
- application to information goods
  immediate, delayed
  high resolution, low resolution
- quality degradation may be better for everyone
- Dupuit quote

Bundling

Sell packages of goods bundled together
- Microsoft Office Suite
- journals = bundle of articles
- subscription = bundle of journals
- bundling journals by subject matter

Example of bundling

Professor A
- will pay $120 for *Journal of Addition*
- will pay $100 for *Journal of Subtraction*

Professor B
- will pay $100 for *Journal of Addition*
- will pay $120 for *Journal of Subtraction*

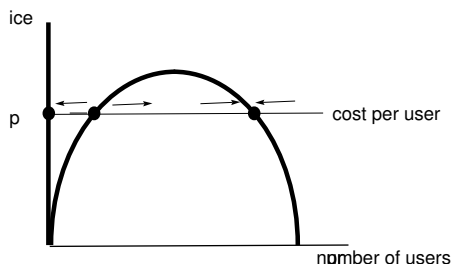
Publisher
- sells journals separately gets $400
- sells bundle gets $440

Network externalities

- my willingness-to-pay depends on number of other users
  - fax machines
  - VCRs
  - software
  - Internet
- model (from Hayashi 1992)
  - type (=v) is uniformly distributed on [0,1]
  - x = fraction of [0,1] that subscribes
  - WTP of someone of type v = vx

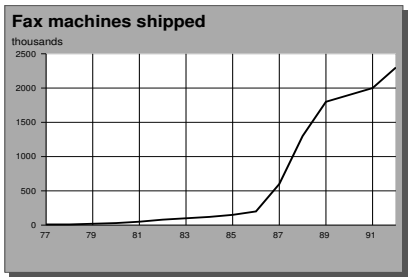
Analysis

let V be marginal subscriber, so $Vx=p$
everyone with higher value subscribes: $x = 1-V$
so equilibrium requires $x(1-x)=p$

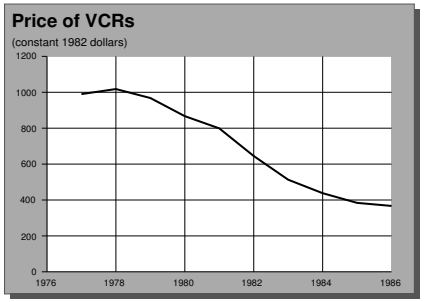


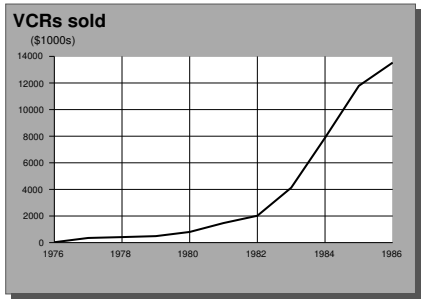
Observations

May need "jump start" to get out of low level equilibrium
Fax market (from Economedies (1994)):



VCR market





Conclusions

Expect to see:

- different prices for different users and uses
- quality differentials to support self selection
- bundling to support cost recovery
- dramatic growth after threshold

Intellectual property

Economic rationale for patents

- property rights encourage innovation
- disclosure encourages cumulative innovation
- but monopoly losses from high prices
- solution: temporary monopoly in exchange for disclosure

  life of patent trades off benefits from innovation + disclosure with the costs of monopoly

Optimal patent

- Nordhaus (1969): 17 years is about right for physical goods

- But is this true for software?

  pace of innovation?

  cumulative nature?
- innovation vs uniformity (Stallman)

  user interface

  compression tools: network externality

Information objects

Cox and Mori: superdistribution

- object (viewer) contains data
- automatically tracks use
- can negotiate other payment schemes
- seems to require secure physical device

  can it really be secure?

  is it really worth the hassle?

Enforcement

- costly to enforce property rights in intellectual property
- true of physical goods
- ...and of ideas

  academic culture

  "Internet culture"

  social norms work best with contained groups

Conclusion: probably should rethink intellectual property law for information goods rather than try to retrofit existing law.