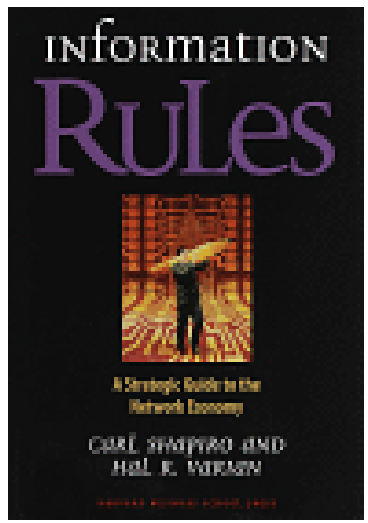
Innovation, Components, and Complements

Hal R. Varian
UC Berkeley

July 3, 2003

Overview

- *Information Rules,* Shapiro and Varian, (Harvard Business School Press, 1998)
- What can we learn from history?
  - Technology revolutions
    - Nature of innovation
    - Business problems
    - Policy problems



Stylized facts about innovation

- Importance of *simultaneous innovation*
- Critical role of
  - Components
  - Complements
  - Standards
- History can motivate ways to think today's business strategy

Simultaneous innovation

- Historical
  - Howe/Singer ...
  - Edison/Swan ...
  - Bell/Gray ...
- Recent
  - Digital computer
  - Personal computer
  - Dot coms

Why simultaneous innovation?

- Demand side
  - Recognized need
  - Problem seems solvable
- Supply side
  - Standardized components
  - Parallel experimentation
  - “Combinatorial innovation”
  - Subsequent development of complements

Examples

- Historical
  - Standardized parts in the 1880s
  - Wright Brothers in early 1900s
  - Edison Menlo Park laboratory
- Recent
  - Integrated circuit
  - Web components
    - Particularly rapid innovation due to...

Components and complements

- Components
  - Standardized interface, ubiquitous, cheap
  - Often developed for some other purpose
  - Part of a more complex system
  - Examples: screws, chips, TCP/IP, etc.
- Complements
  - Value to user depends on system: DVD player+disks, autos+gasoline, 3G+apps
- Often components assembled by manufacturer, complements assembled by user (but many exceptions)

Complements

- Supply side: cheaper to produce one product if also produce other
  - Economies of scale: decreasing unit costs
  - Economies of scope: shared facility
- Demand side: value of one product is enhanced by other
  - Scope: hamburger+catsup, VRC+tapes
  - Scale: fax machine+fax machine
- Book to read: Brandenburger and Nalebuff: *Co-opetition*

Consumption complements

- Complementary products: value to user depends on whole system
  - Radio/TV + content
  - DVD player + disks
  - Computer + storage
- Fundamental questions
  - How is coordination accomplished?
    - Chicken and egg problem with new system
    - Technology evolution with existing system
  - Who does “system integration”?
  - How to divide value up among complementors?

Examples from Silicon Valley

- Question about coordination
  - 3Com: “must align with others”
  - Adobe: works with printers, integrators, VARs, CPU manufacturers
  - Juniper: other network manufacturers, other layers
  - Seagate: “drives are always part of a larger system”
- Moore’s Law as coordination device to avoide bottlenecks for technology treadmill?

Working with complementors

- Two sorts of problems
  - Coordination
    - Everyone have same objectives, major problem is in organization and management
  - Incentives
    - Different objectives lead to working at cross-purposes
  - Normal case is a mixture of two problems

Pure coordination problems

- A natural leader emerges
  - E.g., a system integrator, or someone who controls a standard or bottleneck
  - Extremely powerful position (Microsoft)
  - Counterfactual history: what if IBM had used proprietary hardware in PC, and encouraged competition for OS?
- One side aborbs other (merge or acquire)
  - But can be hard to succeed due to differences in technology
    - Sony/Columbia example
    - AOL-Time Warner

Coordination technology

- Coordination is easier now because of technology
  - Fax, email, attachments, intranet, etc.
  - Databases: Pixar example
- Impact on boundaries of firm?
  - Lower communication cost means...
    - Easier to coordinate across firms
    - But also easier to coordinate within firm (history)
  - High-powered incentives across separate firms
    - Everybody likes competition among suppliers...
  - Answer: will the good/service being spun off be supplied competitively?
    - Depends on demand/supply side economies of scale...

Incentive problems

- Two problems (among many)
  - Price/quality choices
  - Holdup
- Other problems for some other time
  - Channel conflict
  - Information sharing

Example: pricing

- Two components to system, e.g., hardware/software
- Cut price of hardware, increases sales of software and vice versa
- Not necessarily taken into account in price-setting calculation by single firm
- Result: system price is too high, *both* companies benefit from both reducing price
  - Consumers benefit too
  - Coordinating prices of complements is a win all the way around

Pricing complements

- Value to user depends on all components
  - Left shoe+right shoe, hardware+software, DVD player + disks
- So demand depends on sum of prices
- Revenue = $p_1 D(p_1+p_2)$
  - Cutting your price may raise revenue
  - Both cutting prices raises revenue for each
  - Other firm cutting its price raises your revenue the most! How to accomplish this?
  - Big win to coordinating "quality" as well
    - Quality of system may depend on $\min(q_1,q_2)$, as in a network

Solution: ways to cut complement's price

- Integrate: set price yourself
- Negotiate: I'll cut mine if you cut yours
- Collaborate: e.g., revenue sharing
- Nurture: work with them to lower costs
- Commoditize: make their industry more competitive

Cut complement's price: integrate and negotiate

- Integrate
  - One firm sells both hardware and software (e.g., ethernet cards and drivers)
  - Also important for quality reasons (e.g., Sun)
  - Problems
    - Complexity management
    - Core competency
- Negotiate
  - DVD Forum: negotiated to push prices down
  - Note: coordination/integration of prices is a win for both consumers and producers. Antitrust implications.

Cut complement's price: nurture

- Improve quality of complements
  - Microsoft Windows Hardware Quality Labs
  - Cisco Certified Internetwork Expert
  - Auto industry working with suppliers/complementors
- Push costs of complementors down
  - Standardize
  - Communicate effectively
  - Supply chain management, etc.

Cut complementor's price: collaborate

- Revenue sharing
  - VCR "guaranteed in stock"
  - Boeing 747s
  - RFid tags
- Need monitoring/tracking technology

Cut complement's price: commoditize

- Hardware maker wants cheap software, software maker wants cheap hardware
- How to achieve?
  - Push for standards in complementor's industry
  - Demonstration projects
  - Encourage competition
    - Enter yourself to jump start industry
    - Minority investments
- Examples
  - Early history of radio, RCA, AT&T
  - Wintel: extraordinarily productive, necessarily tense
  - Killer app for broadband (P2P?)

Problem: hold-up

- One complementor may try to hold up the other (put them in a position where they have no choice and extort),
  - Unilaterally raise price of critical component
  - Assert intellectual property rights on key component
  - “Lowball the bid and make it up on change orders”

Solutions to hold up

- Contracts
  - But there are negotiation/verification costs
- Commitment device
  - Posting a bond
- Dispute resolution procedures
  - Binding arbitration
- Second sourcing
  - Creates competition
- Repeated interaction
- Reputation

Networks: a kind of system

- Value of technology depends on number of users (aka Metcalfe's Law)
- Direct network effects
  - Fax machine + fax machine
  - Email + email
- Indirect network effects (complements)
  - Web browser + server
  - Intel PC + Windows OS

Network effects, cont.

- Economics literature
  - Rohlfs: Critical mass
  - Katz and Shapiro: Strategy to achieve critical mass
- Examples of network effect
  - eBay
  - Visa
- How to get to critical mass [details follow]
  - First mover (or even better: fast follower)
  - Penetration pricing
  - Expectations management
  - Alliances

Penetration pricing

- Subsidize early adopters
  - Introductory pricing
  - Favored groups (e.g., NSFNET and Internet subsidies to universities)
- Give away bundled samples of complement
  - VCRs + video clubs, DVDs

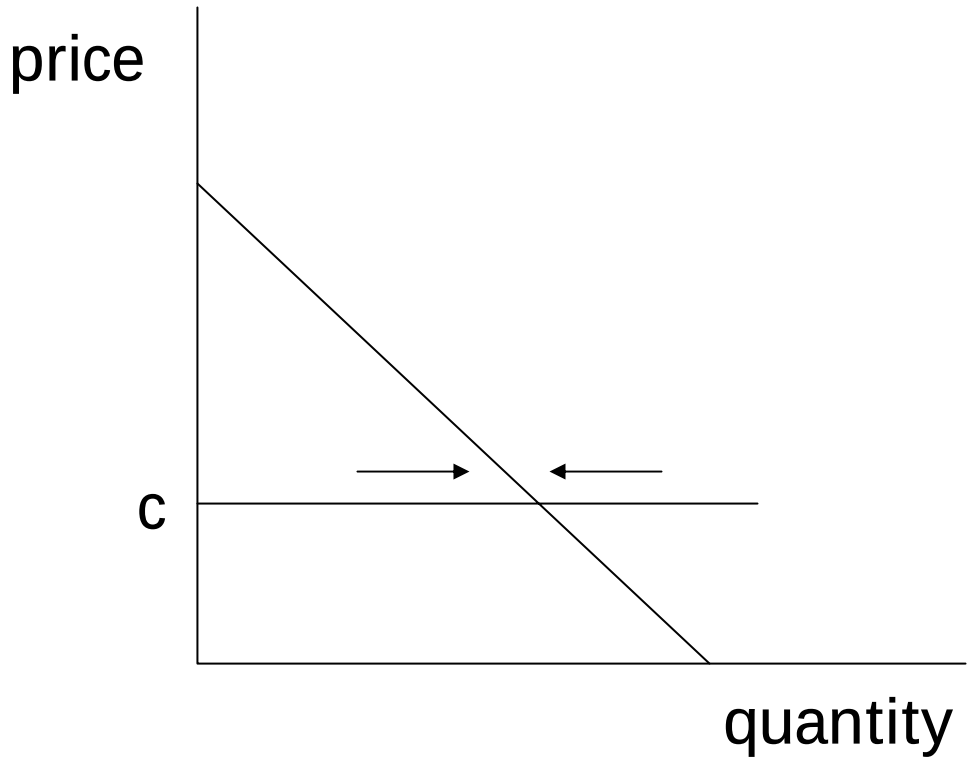
Expectations management

- Reputation, vaporware, pre-announcement
- Build industry alliance (Java)
- Don’t allow fragmentation (Divx)
- Synchronize product introduction
- Solve standardization, complements pricing problem
- Examples
  - How to do it: DVD
  - How not to do it: eBooks

Demand and supply (standard case)

- Suppose consumers have value v ~ U[0,1] for good with price p
  - Buy if v > p
  - So demand function: x= 1-p
- Sellers can produce at constant marginal cost c, so price must = c
- So Demand=Supply implies x=1-c
- Standard dynamics: demand > supply -> quantity produced increases

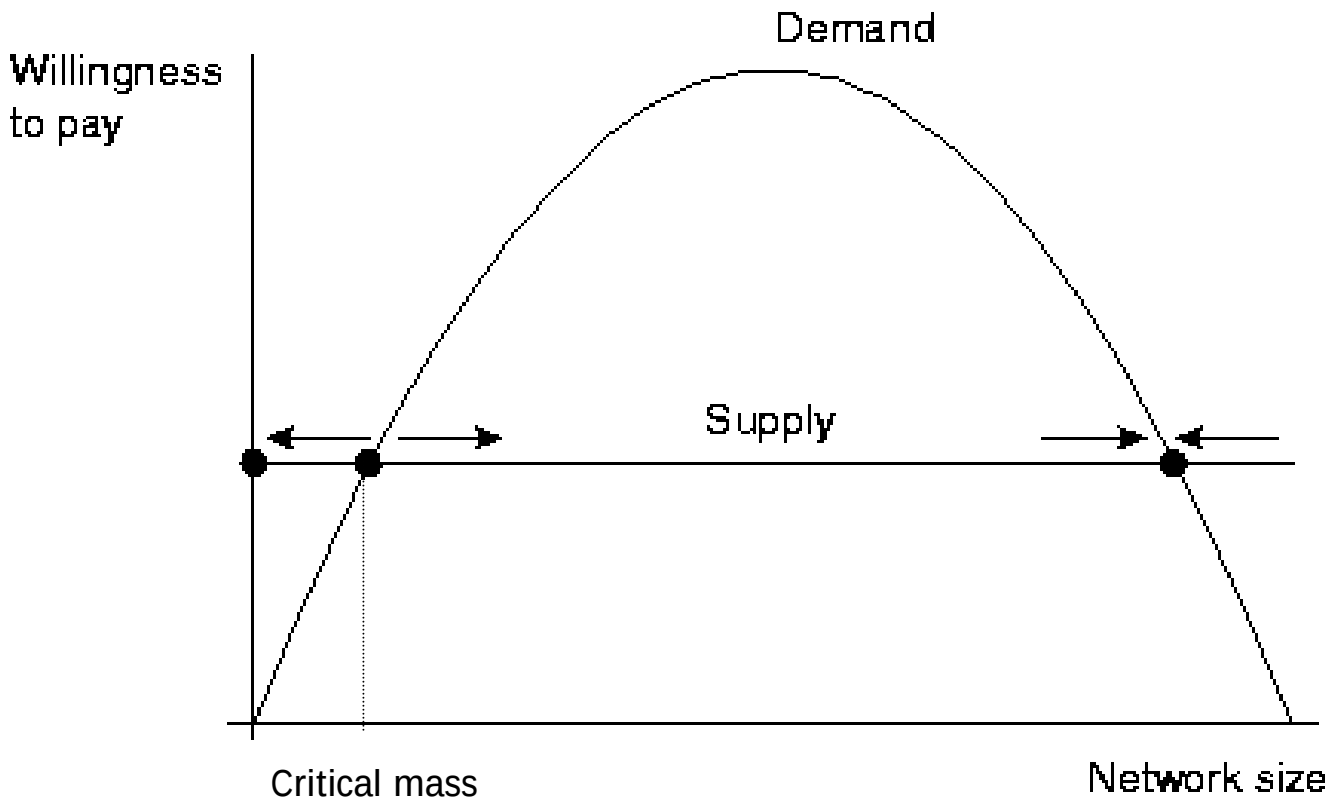
Demand and supply



Network good

- Value depends on “standalone value” and number of adopters
  - E.g., value = vn where v~U[0,1]
  - Let value of “marginal adopter” be v*
    - Marginal person just indifferent: v*n=c
    - Everyone with value greater than v* adopts, so n=1-v*, or equivalently v*=1-n
  - Substitute to find “demand=supply” condition (1-n)n=c

Network dynamics



Standardization and interconnection

- If value depends on size, interconnection is important strategy
  - socially valuable
  - valuable to customers, new entrants, complementors
  - may or may not be good for incumbents
- Your value = your share x value of market[n]

Example: standards in auto industry

- Auto industry
  - 1904-1908: 240 companies entered auto industry (suppliers and assemblers)
  - 1910: recession
  - Ford pulled ahead by mastering mass production
- Standardization
  - Suppliers: wanted stability
  - Assemblers: wanted economies of scale
  - Solution: Society of Automotive Engineers
- Problem
  - Dominant incumbents: Ford and GM

Effects of standards

- Competition, learning curve and scale economies: all reduce costs
- Risk reduction (shocks, holdup, etc.)
- Provides components for innovation
- Problem with conflicting goals:
  - Want other guy's stuff to be standardized
  - You want your stuff to be proprietary

Types of standards

- Formal standards setting bodies (IEEE, ITU, EIA, etc.)
- Ad hoc standards setting bodies
- Proprietary “standards”

Issues

- Tradeoff between too much and too little control
  - One firm controls a standard
    - But can they get away with it? Micropayments.
  - No one controls a standard
    - Fragmentation. Unix
- Speed/Quality
  - Standards bodies v ad hoc standards groups
  - Premature standardization
  - Standards wars

How to get an edge in standardized industry?

- Manufacturing skills (HP)
- Proprietary extensions to standard
- Be first to market, ride learning curve
- Understand technology/market better
- Be complementary to something cheap and ubiquitous

High-tech challenge today

- “What do users want?”
  - To do the same things better, cheaper, faster, etc.
  - To do new things
- Biggest challenge facing industry: complexity management
  - Solution requires better needs assessment, human interface, design, testing, etc.
  - Lesson of Bose speakers
  - What do users want from IT?

Why simplicity?

- Users *are* the bottleneck; no Moore's Law for neurons
- Systems will work better if weakest link is better (interface with user)
- One solution: self-contained, pre-configured or auto-configured systems

Pre-configured systems

- Give up customization, reduce diversity
- Impact on innovation?
  - Makes it harder to innovate in some ways
    - PC as generic platform for experimentation
  - Easier to innovate in others
    - Yesterday's system becomes today's component
    - Starts innovation all over again!

Take away questions

- Who are your complementors?
- Look at the system from the end-user's point of view. Where are the bottlenecks?
- How can you get the producers of components/complements to improve quality, lower price?
  - Integrate, collaborate, negotiate, nurture, commoditize, etc.
- How can you coordinate actions and align incentives better with complementors?