

# Lecture # 23 – Economics of Information

## I. Markets for Information Technology

- Today we begin the section of the course on information technology. We begin by looking at the economic issue raised by information technology, and discussing what role policy can play in IT markets.
- Before asking what role policy can play, we need to consider how markets for IT work.
- Markets for information
  - We begin by looking at incentives provided by markets for producing information itself.
  - Our focus is on information as a commodity.
  - What is an “information good”?
    - An information good is anything that can be digitized, such as a book, song, or telephone conversation.
    - The problem is similar to R&D: there are fixed costs to producing knowledge, but IT makes the dissemination of knowledge very inexpensive.
      - One difference is that the knowledge generated by R&D typically is embodied elsewhere (in a product, or tacit knowledge as part of someone’s human capital).
      - An analogy would be that the results of R&D become “information” when they are written down (e.g. a book, patent, or blueprint).
    - Marginal cost pricing (what Shapiro and Varian refer to as “incremental” pricing) would encourage efficient dissemination of the information, but will not enable firms to recoup the fixed costs of creating knowledge.
  - Characteristics of information
    1. Experience good – you must experience the information to know what it is.
    2. Returns to scale – the fixed costs of creating information are high, but the marginal costs of dissemination are low.
    3. Public goods
      - Note that knowledge can be similar to, but is not exactly, a public good.
      - Public goods have two features:
        - Non-rival: anyone can use it without affecting someone else’s enjoyment
        - Non-excludable: it is difficult to prevent people from using the good, so that they are able to free ride.
      - Unless there is congestion, knowledge is non-rival.
      - However, exclusion is possible.
        - One might argue that exclusion is not desirable if the marginal costs of dissemination are low. However,

this does not change the fact that exclusion is possible.

- Rather, we choose to make some goods non-excludable because it is cheaper to do so (e.g. free roads vs. toll roads)
  - Thus, if we would like private markets to provide knowledge, it is possible.

○ Experience goods

- Consumers can only know if they want to buy information after they know what it is. But once they've seen it, do they need to buy it?
- How can firms deal with this?
  - Previewing and browsing
    - E.g clips of movies or music, browsing books in a bookstore before buying, online versions of books
    - The National Academy of Sciences Press found that sales increased by a factor of three when they posted the full text of a book
  - Reviews
    - E.g. movies, books, music
    - In the sciences, peer review serves the same purpose.
  - Reputation
    - Reputation of previous quality makes people willing to purchase information today.
    - E.g.: *The Wall Street Journal*, *The New York Times*, *Economist*

○ Returns to scale

- Producing knowledge is expensive, but distribution is cheap.
  - Not just true for data, but also for music, movies, etc.
  - Not only are fixed costs relatively high, but they must come before production, and are hard to recover if the information good fails.
  - Marginal cost pricing would not allow firms to recover these fixed costs.
- How markets deal with this
  - Information is rarely sold in perfectly competitive markets
  - Rather, information goods are highly differentiated.
    - Entertainment is an example
    - Private database providers may add value to data in different ways.
- Market power allows price discrimination
  - Price discrimination is when sellers charge different prices to different users
- First-degree price discrimination
  - Charging a different price to each consumer

- Can charge full WTP, so that the firm captures the full consumer surplus
- Note that this is efficient, as everything that should be produced is. However, all the benefits go to producers.
- This model assumes full monopoly power. In practice, most information goods face monopolistic competition, so prices cannot be too high.
- IT can make customization possible (e.g. customized home pages on newspapers, Amazon.com)
- Second-degree price discrimination
  - Setting different prices for related prices
    - E.g. different versions or product lines
      - Hardcover vs. paperback
      - First-run movies vs. pay per view vs. DVDs
      - For IT, Yahoo charged \$9.95/month for real time stock quotes, but gave prices with 20-minute delays for free.
  - Challenge for firms: avoid competing against themselves
    - Differences must be enough so high WTP consumers don't decide to choose low-price product instead.
- Third-degree price discrimination
  - Charging different prices to different types of users
    - E.g. senior & student discounts, Saturday stayovers for airlines
  - Again, the firm captures more of the consumer surplus.
- How does price discrimination help?
  - Price discrimination allows the firm to capture some consumer surplus
  - This allows them to cover fixed costs
  - At the same time, by still allowing low WTP consumers access, dissemination is greater than with a single price.
  - It is important to keep in mind that, without price discrimination, there is no guarantee that firms will choose to only sell at the LOW price.
    - For example, if drug companies could not price discriminate across countries, would they charge low prices in the U.S., or stop selling to developing countries?
  - Note that there may be a role for government enforcement here. If price discrimination is not possible (e.g. because low-price purchasers can resell a good), price discrimination will not allow firms to use high-value users to cover fixed costs.

- If market concentration is necessary for markets to provide information, what keeps firms from charging overly high prices?
    - Even monopolists can only charge as much as consumers are willing to pay.
    - Competition to acquire a monopoly
      - In an effort to gain long-run market power and loyalty, firms may initially set prices lower, benefiting consumers.
    - Reduction in fixed costs
      - In some industries, IT has lowered fixed costs, enabling more entrants.
      - E-commerce is a good example.
      - Particularly useful in industries where variety is important.
    - Competition with prior versions of your own product
    - Pressure from complementary products.
- Switching costs and lock-in
  - Because of network externalities, switching costs are important for IT.
    - Consider, for example, the cost of switching operating systems.
    - One study found the costs of switching operating systems to be 11 times greater than the cost of the software itself.
  - Switching costs have the potential to lead to lock-in
    - Consumers will not switch to a new product unless the improvement is substantial enough to justify the switching costs.
  - Implications for markets:
    - Competition for new users
      - If it is difficult to get consumers to switch, competition for new consumers is intense
        - E.g. ink jet printers: the printers are cheap, toner cartridges are not.
      - In effect, such competition is a form of price discrimination in which high-demand users are charged more, since the marginal costs of frequent usage are high.
    - Price discrimination
      - Firms such as Microsoft would like to set higher prices for current users than new users, as current users are less likely to switch to a competing product.
      - E.g. student discounts

## II. The Role of Government

- Having discussed the role that private markets can play, we now discuss what role the government can play in IT.
- Varian lists three areas for government involvement:
  1. Creation and dissemination of information
  2. Development, regulation, and usage of information infrastructure
  3. Institutional and legal infrastructure
- To begin, Varian lists several general principles appropriate for analyzing the government's role in IT. Some important ones are:
  - Benefits and costs
    - Is the project efficient? Do the benefits justify the costs?
    - Note that it is not enough to ask if the net benefits of a project are positive. We must also consider whether private markets would provide the product. That determines the marginal benefits of government provision.
  - Funding
    - Who should pay for provision?
    - Efficiency suggests that users pay marginal costs. Is this feasible?
    - Are there equity considerations?
  - Are there externalities or public goods considerations
  - If private markets develop, is there sufficient competition (or potential competition)?

### A. Creation and Dissemination of Information

- Based on the above, Varian argues that the government should not be involved in the creation or dissemination of information unless:
  - The information generates positive externalities
    - As noted before, information has some characteristics of a public good, but it can be excludable.
  - Private production of the information would be monopolized, or
    - This may be a problem. As noted before, control over information is important for private firms to have incentives to take on the fixed costs of production.
  - The government will be more efficient at producing the information
    - Most likely when the government collects the data itself.
      - *The Economist* article notes there are many valuable uses to data collected by the government (see article for examples)
        - GPS
        - Weather data
      - Even in these cases, there may be a role for private firms.
        - Government often provides data in raw forms
          - E.g. USPTO vs. commercial patent databases
          - Services providing a map of crimes are more valuable than a list of crimes

- Dissemination of information
  - Once the fixed costs of information are paid, marginal costs of distribution are low.
  - Thus, broad distribution is desirable.
  - However, even in the case of information created by the government, there still is the question of cost recovery.
    - User fees are desirable
    - Government projects are typically financed by tax revenue.
      - In this case, the costs of taxation (deadweight loss) must be considered.
      - Economists estimate the cost of raising \$1 of government revenue to be between 9 and 16 % of revenue. That is, \$1 of government spending imposes a cost on society between \$1.09 and \$1.16.

### *B. Development, Regulation, and Usage of Information Infrastructure*

- A second potential role for the government is infrastructure.
- Network externalities may slow diffusion. Government intervention can help achieve “critical mass.”
  - The Internet is an example. Early government subsidies helped the Internet reach critical mass.
- Note that the private sector has also dealt with this problem.
  - For example, in the early 1980s, video rental stores rented VCRs along with movies. This increased the demand for both products.
  - For Varian, the key question is whether the network externality can be internalized by private markets.
    - Example: when the basic technology needs to be proven.
    - Also, the government can play a role simply by being a major demander of a product.
  - Example of private markets dealing with coordination: standards for DVDs
    - First case: DVD standard in 1995
      - Sony and Philips proposed a technology called MMCD
      - Toshiba proposed a technology called SD
      - Hollywood demanded a single format
      - The result was a compromise that was similar to SD but incorporated elements from MMCD.
    - Second case: recordable DVDs.
      - Here, the industry split into two groups:
        - DVD Forum (Apple, Hitachi, NEC, Pioneer, Samsung, and Sharp) advocate DVD-RAM, DVD-R, AND DVD-RW formats.
        - DVD+RW Alliance (Dell, Hewlett-Packard, and Phillips) supports DVD+RW and DVD+R formats.

- Because of the dispute, players that can read and write both types have been marketed.
- Third case: a similar problem now exists for newer high definition DVDs.
  - The two standards are:
    - HD-DVD: backed by Toshiba, NEC, and Sanyo
      - First devices to come out early 2005.
    - Blu-ray: backed by Sony, Matsushita, Hitachi, and Philips.
      - Have been sold in Japan since 2003.
  - Both of these new DVDs will offer more storage capacity and better picture quality.
    - HD-DVD holds 15 GB
    - Blu-Ray holds 25 GB
    - Current DVDs hold 4.7 GB
  - HD-DVDs are cheaper, because they are an incremental improvement.
  - However, Sony wonders whether people will buy new equipment for an incremental improvement. They prefer to go for higher quality to convince people to replace current DVD players.
  - Developing players capable of using both will be difficult.
  - The role of Hollywood (note: complementary products)
    - In December, 2004, four Hollywood studios announced they would release DVDs in HD DVD format.
    - This follows Sony's announcement that they were assembling a group of inventors to purchase MGM. Presumably MGM would then use Blu-Ray technology.
    - Fox also joined the Blu-Ray group, but have yet to release DVDs in that format.
    - PlayStation3 also plays Blu-Ray DVDs, while Microsoft's Xbox 360 accepts HD-DVD.
    - Warner Brothers and Paramount previously released videos in both formats.
      - Paramount announced they would only produce HD-DVD in August of 2007.
      - Warner Brothers announced they would only produce Blu-Ray discs in January of 2008.
      - After Warner Brothers announcement, Wal-Mart and other retailers dropped HD-DVD
    - On February 19, 2008, Toshiba announced it would stop producing HD-DVD devices. Paramount announced it will again produce Blu-Ray discs.

- When network effects are present, standardization becomes important.
    - Dominant firms (e.g. Bell System before deregulation) have less interest in standardization, as it will not benefit them.
    - How can firms internalize network effects?
      - Market pressure can force firms to agree on a common standard.
      - Integrating products
        - Warner Brothers is developing a new disc that can play programs in both Blu-ray and HD-DVD.
          - Thus, the confusion over standards offers an opportunity for a new product.
        - These discs are more expensive, but would work on both players.
          - Will consumers pay more for this flexibility?
          - Will stores stock yet another format?
          - That Blu-Ray seems to have won the format war shows the risks to innovating when things are unsettled.
      - Licensing technology
        - E.g. Sony and Phillips licensed CD technologies to encourage production.
- One IT infrastructure issue that Varian does not mention is management of the wireless spectrum (now covered in “A Clash Over Airwaves) and “From Lottery to Oligopoly in Wireless Spectrum”
- History of allocating cell phone spectrum
  - Cell phone spectrums originally allocated to big cities
  - Proved to be complicated to choose which cities, so moved to a lottery
    - Many individuals entered the lottery to win and sell licenses
  - In response, government began leasing spectrum to highest bidder using Dutch auction in 1993
    - Begin with a high offer price, and lower offer until one bidder accepts the price
    - From 2001-2010, earned \$33 billion
- As wireless technologies grow, allocating the digital spectrum becomes more difficult.
  - The spectrum is considered a limited resource.
  - Property rights are granted for a single use on each frequency.
  - Thus, scarcity is an issue.
- Initially, central planning was used to allocate access (Radio Act of 1927 and Communications Act of 1934).
- 1959: Ronald Coase argued that the electromagnetic spectrum should be allocated using markets.
  - First auctions of the spectrum began in 1995.
  - Telecoms purchased the most.
  - Only about 2% of the spectrum is auctioned off.
- Examples of the value of the spectrum:



- In 2004, Nextel got access to new portions of the wireless spectrum in return for vacating other bands that were interfering with emergency radios. The deal cost Nextel \$3.25 billion.
- Verizon Wireless purchased a portion of the spectrum in New York for \$930 million.
- One think tank estimates that America's airwaves were worth \$771 billion in 2001, but that half of this is wasted because it is not put to its best use (e.g. extra broadcasting capacity, rather than cell phones).
- In 2003, the FCC began allowing leasing and trading of frequency licenses.
  - As a result, property rights to the spectrum are assigned.
  - Until then, the FCC simply decided on its own which portions of the spectrum were allocated to each use.
- What advantages does trading bring?
  - Helps to ensure that frequencies are put to their highest value use.
    - Underused frequencies could be leased, for example, to cell phone companies, allowing greater coverage.
    - News agencies could buy extra frequency during high-profile events (e.g. the Olympics)
- Now, government about to sell last large chunk of low frequency spectrum for wireless services. Sale likely to be complete by 2015
  - Reacquiring spectrum no longer valuable to TV broadcasters
    - Currently, there is space between frequencies to avoid interference. This is what the government wants to reclaim.
      - Tighter spectrum could cause interference to those receiving TV over the air.
      - Won't affect cable or satellite users.
    - However, broadcasters are not happy with the plan. They disagree that it is voluntary
    - Will reorganize into a single bundle to sell to wireless companies
    - Does this create too much market power for large cell phone companies? Can they purchase spectrum to keep out competition? Should there be limits on the amount they can purchase?
      - In the last large auction, AT&T and Verizon purchased 80% of the available spectrum.
      - Sprint and T-Mobile lacked financial resources, and did not even bid.
      - Using a lottery would earn less money for the government, but would foster competition that could save consumers money.
        - However, that would decrease its value, and thus decrease the amount earned in the auction.

- An alternative model is treating the spectrum as a common resource.
  - Advocates of this argue that scarcity of spectrum space depends not on laws of nature, but on the nature of technologies used.
    - Older technologies needed different channels to allow communication without interference.
    - Newer wireless devices can communicate over a broad range of frequencies at once and adapt to local conditions.
    - Open access may provide more competition, leading to better quality service.
      - Note, for example, that broadband Internet services in the U.S are slower than many other developed countries.
      - A lack of access has limited competition (typically one cable company vs. one telecommunications company in each area).
  - They also are concerned about the transactions costs necessary for obtaining access.
    - Would lack of access to the spectrum slow innovation?
    - Will current rights holders have incentives to develop new uses for the spectrum?
    - An open-access policy would provide incentives for new entrants to develop competing technologies.
  - Currently, the FCC is using a hybrid approach.
    - While they have begun auctions, they have also set aside some parts of the spectrum for uses not requiring a license.
      - Wi-Fi (officially called 802.11) operates in this unlicensed band.
    - In these bands, vendors, rather than the government, must sort out interference problems.
    - In November 2008, the FCC voted to approve new uses of white space in the radio spectrum
      - The FCC will require users to demonstrate that their technology will avoid interference with existing users by switching to another frequency when a given frequency is protected.
  - Incumbents argue that the move to a commons property approach should move slow.
    - Concerns:
      - What to do about interference? Can you guarantee it won't be a problem?
      - Security: some bands should be kept for vital uses.
        - Underlaying (transmitting signals in someone else's licensed band) may help, since incumbents won't need to give up their property rights.
        - Note the political economy concern here: property rights provide advantages (and economic rent) for established firms.

### C. Institutional and legal infrastructure

- We will deal with other regulatory issues, such as network neutrality, in the next lecture. Today we focus on one specific issue: file sharing and copyright laws.

### III. File Sharing and Copyright Laws

- Background
  - Much of the controversy over copyright laws and digital technology revolves around sharing digital music files.
  - The recording industry has complained about reduced sales since downloading began.
    - From 1999-2008, revenue from physical recorded music products in US fell from \$12.8 billion to \$5.5 billion.
    - Even including digital sales, US revenue is 1/3 below 1999 levels
  - What might be the reasons for reduced sales?
    - Downloading
    - Weaker economy
    - Competition from other forms of entertainment, e.g. DVDs/video games
    - Quality
      - Reduction in sales corresponds with consolidation in music industry. Is it harder for new acts to get exposure?
    - Changing demographics
      - Older generation no longer needs to replace old LPs with CDs
  - At the same time, while sales are down, royalties to performers have increased.
    - Thus, there are other sources of revenue
      - Performance
      - Licensing
        - Ring tones are an example
- Key questions:
  - Has file sharing reduced copyright protection for recorded music?
  - If copyright protection has been weakened, has this reduced supply of new products?
- The economic problem is that digital files make the marginal cost of distributing music close to zero.
  - This suggests that wide distribution is optimal.
  - However, free distribution does not reward the creators.
  - Average cost of a CD in Euros:

▪ Recording	2.25
▪ Production	0.25 to 5
▪ Marketing and promotion	0.25 to 5
▪ CD press	1
▪ Margin of retailers	2 to 2.5
▪ Margin of record companies	2.5 to 4

