The Economics of Network Industries

Week 18

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Outline

- Main Characteristics
- Welfare Aspects
- Software Piracy
- New Technology Adoption

Main Characteristics

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    (c) Switching Costs and Lock-In.
    (d) Significant Economies of Scale in Production.

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- Problem of *coordination*

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- Our utility from the consumption of these goods is affected by the number of other people using similar or compatible products
- Such externalities are sometimes referred to as *adoption* or *network externalities*

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- (Very often) Multiple equilibria

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Indirect Network Effects when more applications are available for a hardware, the greater are the incentives for consumers to purchase the system, and the more application writers desire writing applications for this hardware.

Empirical Evidence

Spreadsheet packages: Consumers were found to be willing to pay a significant premium for spreadsheets that are compatible with the Lotus platform (46% on average) and for spreadsheets that offer links to external databases; a 1% increase in a product's installed base is associated with a 0.75% increase in its price.

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Database software: The ability to read and write data in the dominant spreadsheet format is associated with higher prices.

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VCRs: Network effects played a central role in the format competition between VHS and Betamax. It is estimated that (i) the value of the network effect grew from $5.6 million in 1978 to $343 million in 1986 for all US households (in constant 1978 prices), and (ii) the network advantage of VHS explains at least 70.4% to 86.8% of the relative sales of VHS to Betamax in each year between 1981 and 1988.

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Videogames: It is found that an introductory pricing is an effective practice at the beginning of the product cycle, and expanding software variety becomes more effective later.

Switching costs and lock-in

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- First, if consumers are already locked-in using a specific product, firms may rise prices knowing that the consumers will not switch unless the price difference exceeds the switching cost to a competing brand.
- Second, if the consumers are not yet locked-in, brand-producing firms may compete intensively by offering discounts and free complimentary products and services in order to attract consumers who later will be locked in the technology.

Economies of Scale

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- The average cost function declines sharply with the number of copies sold out to consumers. A market with high sunk cost and (almost) zero marginal costs cannot function as perfectly competitive markets!

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- Misallocation of resources could be generated by non-competitive behaviour of firms, or by the consumption externalities

Natural Monopolies Vs Access Pricing

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- Governments licensed only one company in a given region, and in many cases for the entire country
- The idea behind is that it is a social waste to have each competing telephone company wiring its own network into each apartment building, where residents choose different carriers

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- Services were relatively poor and were not improving at the pace of technological advance made in these industries.
- Regulators failed to control prices and other charges levied on consumers. Due to asymmetric information, regulators failed to observe the true production costs so these firms tended to inflate their reported production costs in order to lobby for high prices.

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- Access pricing is now practiced in all network industries.

Two examples

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- Piracy has two economic impacts on software firms:
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  - (ii) It may also boost the demand for the particular software by increasing the size of the installed base

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- The total population is $2n$

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- Let q the number of *users* of the software (legal + illegal)
- The utility of type O consumer is

$$U^O = \begin{cases} (1+\sigma)q - p & \text{if she buys the software} \\ q & \text{if she pirates the software} \\ 0 & \text{if she does not use this software} \end{cases}$$

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Proposition

(a) *Type O consumers would prefer buying the software over pirating if $p \leq \sigma q$, i.e. if the price of the software package does not exceed the value of service provided by the firm to its legal customers.*

(b) *If the software is not copy protected, type I consumers never buys the software. they either pirate or do not use at all.*

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  We are going to see which protection policy is profitable for the software firm.

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$$p^{NP} = \sigma 2n \qquad \text{and} \qquad \pi^{NP} = p^{NP} n = 2\sigma n^2$$

In this equilibrium, each type O consumer buys the software and gains $U^O = (1+\sigma)2n - p = 2n$ and each type I consumer pirates the software and gains $U^I = 2n$.

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- **High Price equilibrium:** at this price only the n type O consumers will buy the software (and since the type I will not buy, $q = n$). The maximal price that a type O is willing to pay and the resulting profit level are

$$p^{P,H} = (1+\sigma)n \qquad \text{and} \qquad \pi^{P,H} = (1+\sigma)n^2 \tag{1}$$

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- Comparing the profit level in (2) and (1) we can see that

$$\pi^{P,H} \geq \pi^{P,L} \qquad \text{if and only if} \qquad \sigma \geq 3$$

P Policy

- Therefore, the monopolist price and profit levels are

$$p^P = \begin{cases} (1+\sigma)n & \text{if} \quad \sigma \geq 3 \\ 2n & \text{if} \quad \sigma < 3 \end{cases}$$

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- **Should the software firm choose to protect the software?**

P Policy

Proposition

When software users' preferences exhibit network externalities,

(a) *no copy protection yields higher profit than copy protection if type O consumers place a high value on service support offered with the legal version, i.e. when* $\sigma \geq 2$.

(b) *copy protection yields higher profit than no copy protection when type O consumers place a low value for service support,* $\sigma < 2$.

Empirical Evidence

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During the same time the percentage of unit sales of buyers due to the influence of pirates has also grown: from 1988 on, more than 80% of the software purchased by buyers was probably the result of the influence of the pirates.

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The percentage of pirated units adoptions due to the influence of buyers decreased over time stabilizing at around 15% in 1987. As expected, all pirated adoptions in the beginning of the diffusion process were due to the influence of buyers because there were not too many pirates.

New Technology Adoption

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- We consider two models: static and dynamic approach

New Technology Adoption: Static Approach

- Consider a technology-adoption game played by two users (or firms)

		User B	
		NEW TECH.	OLD TECH.
User A	NEW TECH.	α, α	γ, δ
	OLD TECH.	δ, γ	β, β

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User A	NEW TECH.	α, α	γ, δ
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- Assume $\alpha > \gamma$ and $\beta > \gamma$

New Technology Adoption: Static Approach

Proposition

Under our assumption ($\alpha > \gamma$ and $\beta > \gamma$), there exist two Nash equilibria for the static technology adoption game given by (NEW TECH., NEW TECH.) and (OLD TECH., OLD TECH.).

New Technology Adoption: Static Approach

Definition

Consider the simultaneous game above and the two relative pure strategy Nash equilibria. Then,

(a) If (OLD TECH., OLD TECH.) is played, and if the outcome of (NEW TECH., NEW TECH.) Pareto dominates the outcome of (OLD TECH., OLD TECH.), then we call this situation **excess inertia**.

(b) If (NEW TECH., NEW TECH.) is played, and if the outcome of (OLD TECH., OLD TECH.) Pareto dominates the outcome of (NEW TECH., NEW TECH.), then we call this situation **excess momentum**.

Example

In the early 1970s, quadrophonic sound was introduced as an alternative to stereo sound for playing audio recording. It was higher quality but it failed to become the new industry standard. Why?

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The initial support quickly faded for two reasons: (i) the technology was not mature enough and some customer was dissatisfied, and (ii) the technology was proposed under several incompatible formats and there was uncertainty about which version would eventually become the industry standard.

New Technology Adoption: Dynamic Approach

- We propose a model which try to identify several important factors affecting the timing and frequency of new technology adoption, including

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    - (a) consumers' degree of substitution between getting a more advance technology, and the network size;

New Technology Adoption: Dynamic Approach

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  - (b) the technology growth rate and consumer population size;
  - (c) the degree in which a new technology is compatible with the old technology to be replaced.

New Technology Adoption: Dynamic Approach

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- The actual technological quality consumed by young consumers in period t is given by

$$V_t = \begin{cases} T_t & \text{if the young at } t \text{ adopt the new technology} \\ V_{t-1} & \text{otherwise} \end{cases}$$

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- The utility of a young consumer of generation τ is given by

$$U^\tau = \begin{cases} u(T_\tau, n_\tau) & \text{young adopt state-of-art} \\ u(V_{\tau-1}, n_{\tau-1} + n_\tau) & \text{young adopt old technology} \end{cases}$$

with $u(\cdot)$ monotonically increasing in both arguments.

New Technology Adoption: Dynamic Approach

- Generation $t = \tau$ young consumers would choose to purchase the new technology product if and only if

$$u(T_\tau, n_\tau) \geq u(V_{\tau-1}, n_{\tau-1} + n_\tau)$$

That is, they will adopt the new technology product if and only if the utility from higher quality product ($T_\tau > V_{\tau-1}$) combined with a low network size is ($n_{\tau-1} + n_\tau \geq n_\tau$) overtakes the utility from the old technology product.

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- We now investigate how the degree of substitution between the quality of the new technology and the network size affects the adoption of new technologies. Two extreme cases: the two components are perfect complements or perfect substitutes.

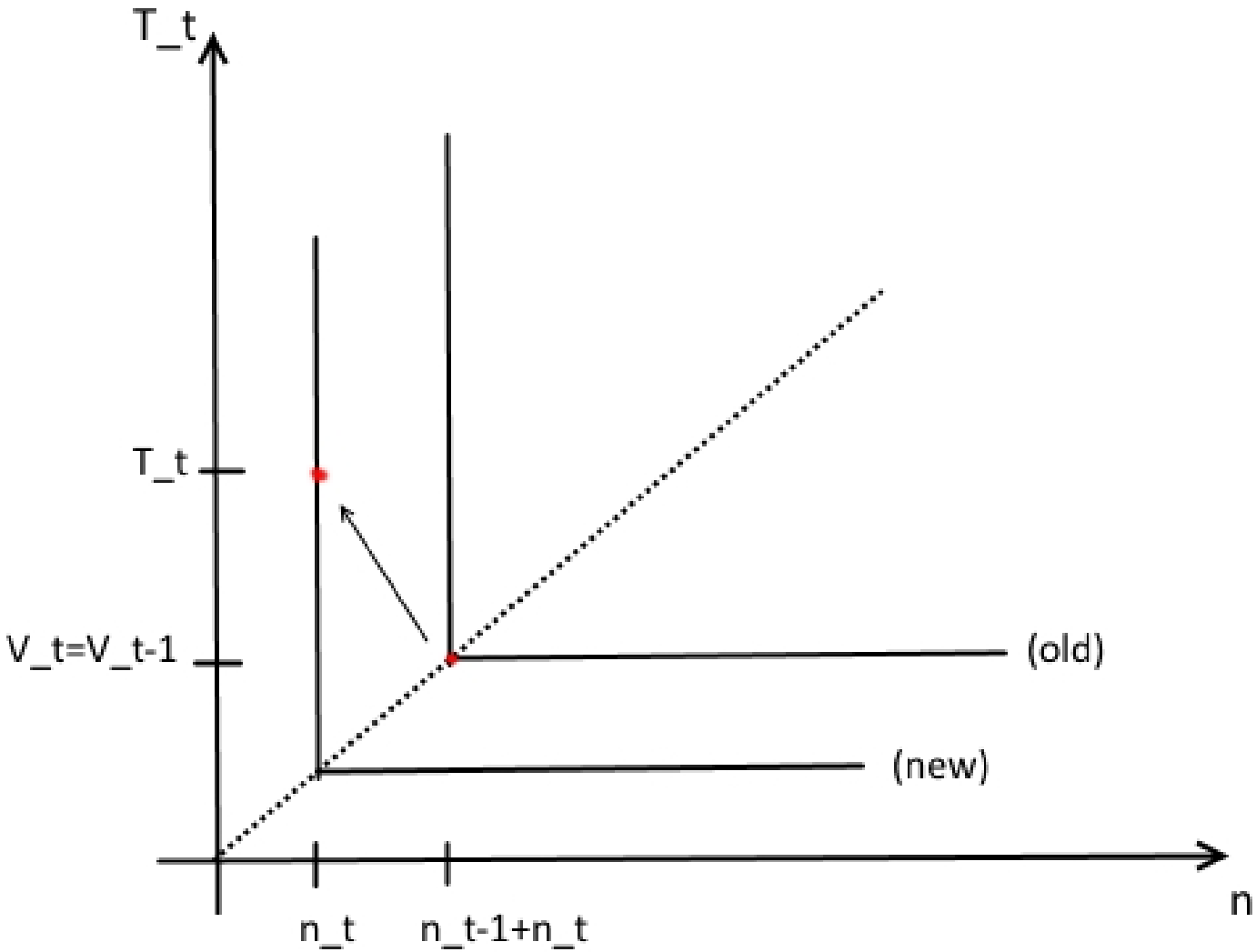
New Technology Adoption: Dynamic Approach

Perfect Complements:

- Consider the preferences for *perfect complements* given by

$$U^{\tau} = \begin{cases} min\{T_{\tau}; n_{\tau}\} & \text{if state-of-art is adopted} \\ min\{V_{\tau-1}, n_{\tau-1} + n_{\tau}\} & \text{if old technology is adopted} \end{cases}$$

New Technology Adoption: Dynamic Approach



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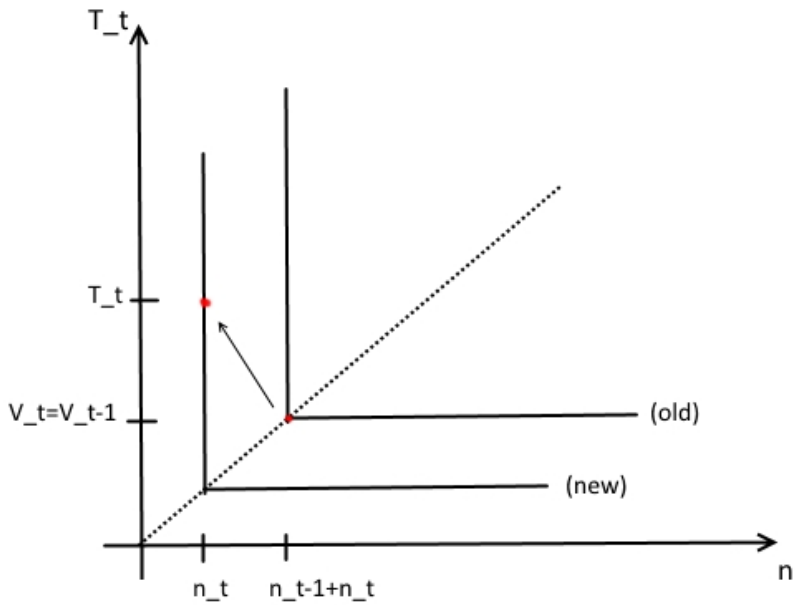


New technologies may not be adopted even if the technology growth rate is very high — *stagnation equilibrium*.

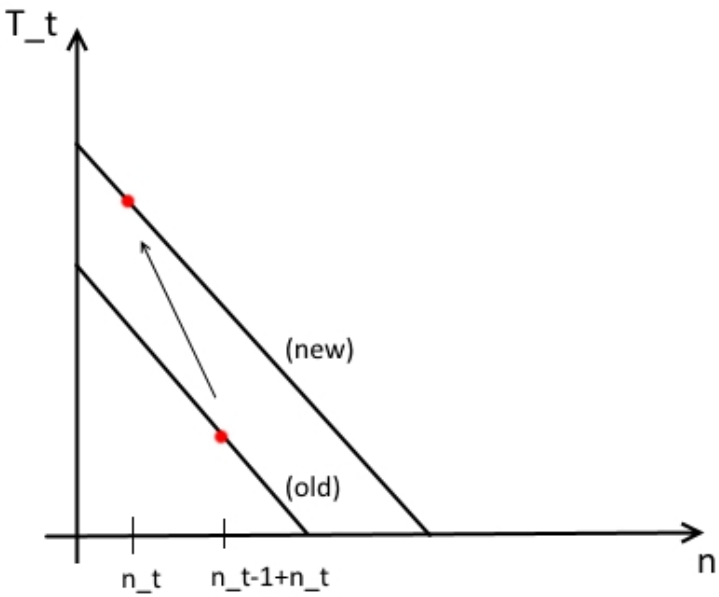
New Technology Adoption: Dynamic Approach

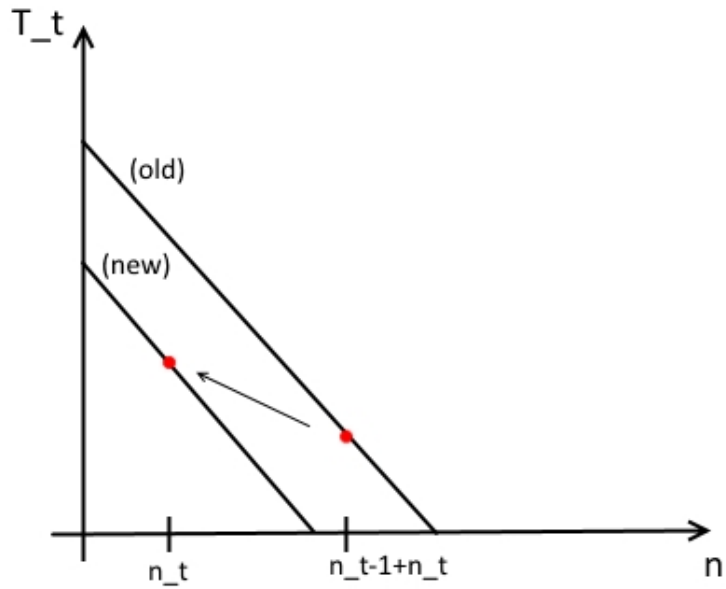
Perfect Substitutes:

- Consider the linear preferences described by

$$U^{\tau} = \begin{cases} T_{\tau} + n_{\tau} & \text{if state-of-art is adopted} \\ V_{\tau-1} + n_{\tau-1} + n_{\tau} & \text{if old technology is adopted} \end{cases}$$

New Technology Adoption: Dynamic Approach





New Technology Adoption: Dynamic Approach

- Since technology growth at constant rate, a new technology is not adopted for several periods as the quality of the state-of-art technology T_τ is not high enough to offset a reduction in network size. Eventually, the gains from adopting the new incompatible technology outweighs the loss in network size.

Heterogeneous adopters for network goods

Most electronic products are characterized by sequential adoption: there is a minority of early adopters and a majority of mainstream customers, who usually take a wait-and-see approach.

Take the example of Blackberry which allowed users to stay connected on the go with wireless access to email. The Blackberry becomes popular among business people, who were valuing highly the possibility of reading and sending emails any time anywhere. Non professional users adopted the Blackberry later.

Heterogeneous adopters for network goods

Consider the example of high-definition television (HDTV). Indirect network effects are present here as HDTV becomes more valuable as more diverse content is broadcast in HD. The early adopters were the so-called "tech aficionados" that were interested in superior picture quality, whatever the available content. The mainstream consumers take a wait-and-see approach and as a result, content producers also wait, slowing down the diffusion of HDTV.