Chapter 2 Compatibility and Standards

- The Network Externality Approach
- The Supporting Services Approach
- The Components Approach

Benefits of Being and Working together

- Production
  - Most production processes involve teams or groups of people using other intermediated products
  - Different workers would be able to use the same machine
  - The output generated by a certain machine would be able to be used by another worker operating different machine
- Consumption
  - People "enjoy" consuming goods that are also used by other people
  - They like to watch the same movies, to exchange books, and to listen to music of the same composers
  - People observe what others buys and try to match their consumption with that of their neighbors

Compatibility and Network Externality

- Definition
  - Brands of products are said to be compatible, if they can work together, in the sense that the output of one brand can be operated on the same standard
  - Brands are said to be downward compatible if a newer model is compatible with an older model, but not necessarily the other way around
  - Consumers' preference are said to exhibit network externalities if the utility of each consumer increases with the number of other consumers purchasing the same brand

Standards

		FIRM *B* Standard α	FIRM *B* Standard β
FIRM *A*	Standard α	*a*,*b*	*c*,*d*
	Standard β	*d*,*c*	*b*,*a*

- If $a,b > \max\{c,d\}$, then the industry produces on an single standard, that is (α,α) and (β,β) are Nash equilibria
- If $c,d > \max\{a,b\}$, then the industry produces on two different standard, that is (α, β) and (β, α) are Nash equilibria

The Network Externalities Approach

- The interdependent demand for communication services
  - n: The total number of consumers who actually subscribe to the phone ($0<=n<=1$)
  - x: consumers indexed by a x. Low (higher) x means high willingness (low) to pay ($0<=x<=1$)
  - $U^x=n(1-x)-p$ if he or she subscribes to the phone system, $U^x=0$ if he or she does not subscribe

The interdependent demand for communication services

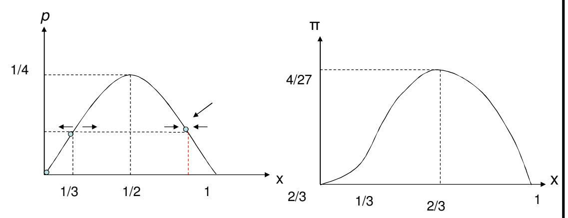
- Indifferent to subscribe or doesn't subscribe $n(1-x)-p=0$
- Demand function $p=x(1-x)$
- The problem of monopoly phone company

  Max $\pi=px=x^2(1-x)$

  FOC $2x-3x^2=0$

  ⇨ $x^*=2/3$

The Network Externalities Approach



The Standardization-Variety Tradeoff

- Assume there are two brands of product and heterogeneous consumers, in the sense that each customer prefers one brand over the other
- We assume a continuum of consumers, normalize the population size to 1
- *a* consumers prefer brand *A* over brand *B*, whereas *b* consumers prefer brand *B* over brand *A*, where $a+b=1$
- The utility of each customer type increases with the number of consumers buying the same brand
- If a customer purchases the less desired brand, his utility falls by δ

The Standardization-Variety Tradeoff

$U^A = x_A$ buys brand *A* $\quad$ $U^B = x_A - \delta$ buys brand *A*

$\quad = x_B - \delta$ buys brand *B* $\quad$ $= x_B$ buys brand *B*

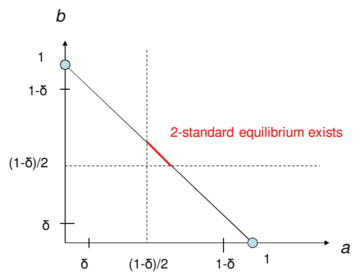
(1) If $\delta < 1$, the two equilibria exist: one in which *A* is the standard ($x_A=1$) and one in which *B* is the standard ($x_B=1$)

(2) If $\delta > 1$, no single –standard equilibrium exists

(3) If the number of each type of consumers is sufficiently large, then there exists a two-standard equilibrium. Formally, if $a,b>(1-\delta)/2$, then $x_A=a, x_B=b$ is an equilibrium

- Proof : $a>b-\delta$ $\quad a>(1-\delta)/2$ (since $b=1-a$)

The Standardization-Variety Tradeoff



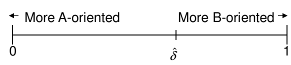
The Standardization-Variety Tradeoff (cont')

- Social welfare $W=aU^A+bU^B$
- $W=\mathbf{a}+b(1-\delta)$ if *A* is the standard
  $=a^2+b^2$ if there are incompatible standards
  $=a(1-\delta)+b$ if *B* is the standard
- Implications
  - (1) if ($a>b$), then standardization on *A* is socially preferred to standardization on *B*
  - (2) If $\delta<1$ then the incompatibility equilibrium is socially inefficient
  - (3) If $\delta>1$ then the incompatibility equilibrium is socially optimal if $a<\delta/2$ and $b<\delta/2$ $(a^2+b^2>a(1-\delta)+b)$
  - (4) An equilibrium in which the industry produces two incompatible brands need not be socially efficient

The Supporting Service Approach

- Each consumer is endowed with *Y* dollars to be spent one unit of hardware and the variety of software written for the specific hardware purchased
- A consumer purchasing brand *i* spends $E_i=Y-p_i$
- N_i is the total number of software packages that can be run on an *i* machine, $i=A,B$
- Consumers are uniformly indexed byδon the interval [0,1] according to their relative preference towards computer brand *B*
- The utility of a consumer type δ is defined as

$$U^\delta = \begin{cases} (1-\delta)\sqrt{N_A} & \text{if she is an A-user} \\ \delta\sqrt{N_B} & \text{if she is a B-user} \end{cases}$$



The Supporting Service Approach

The customer who is indifferent to the choice between systems *A* and *B* is denoted by $\hat{\delta}$, which can be found from $(1-\hat{\delta})\sqrt{N_A} = \delta\sqrt{N_B}$

⇨ $\frac{B\text{'s market share}}{A\text{'s market share}} = \frac{(1-\hat{\delta})}{\hat{\delta}} = \sqrt{\frac{N_B}{N_A}}$

Assume the number of software packages supporting each brand is proportional to aggregate expenditure of the consumers purchasing the brand-specific software

$$N_A = \hat{\delta}E_A = \delta(Y-p_A) \quad \text{and} \quad N_B = (1-\hat{\delta})E_B = (1-\delta)(Y-p_B)$$

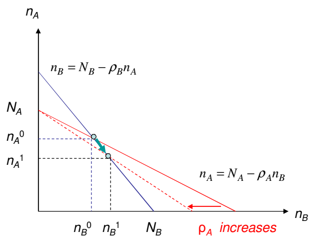
⇨ $\hat{\delta} = \frac{E_A}{E_A+E_B} = \frac{Y-p_A}{2Y-p_A-p_B}$ ⇨ $\frac{\partial\hat{\delta}}{\partial p_A} < 0 \Rightarrow \frac{\partial N_B}{\partial p_A} > 0$

Partial Compatibility

- **Definition:** A computer brand *i* is said to partially compatible with a ρ_i ($0<=\rho_i<=1$) degree of compatibility with computer brand *j* if a fraction ρ_i of the total software written specifically for brand *j* can also be run on computer brand *i*
- The number of software packages written specifically for machine *i* is denoted by n_i, *i*=*A*,*B*
- The total number of software packages available to an *i*-machine user is equal to

$$N_A = n_A + \rho_A n_B \qquad N_B = n_B + \rho_B n_A$$

Partial Compatibility (cont')



⇨ $\frac{\partial n_B}{\partial \rho_A} > 0; \frac{\partial n_A}{\partial \rho_A} < 0 \Rightarrow \frac{\partial N_B}{\partial \rho_A} > 0; \frac{\partial N_A}{\partial \rho_A} < 0$

⇨ Compatibility with the rival machine's software will induce software writers to write more software for the rival machine and make it more attractive

The Components Approach

- Matutes and Regibeau (1988), Economides (1989)
- Consider a product that can be decomposed into two (perfect complement) components
  - E.g. a computer system can be decomposed into a basic unit and monitor
  - A stereo systems can be decomposed into an amplifier and speaker
- We denote the first component by *X* and the second component by *Y*
- There are two firms capable of producing both components
  - X_A (X_B) the first component produced by firm *A*(*B*)
  - Y_A (Y_B) the second component produced by firm *A*(*B*)

The Components Approach (cont')

- Definition
  - The components are said to be incompatible if the components produced by different manufacturers cannot be assembled into systems. That is X_AY_B and X_BY_A do not exist in the market
  - The components are said to be compatible if the components produced by different manufacturers can be assembled into systems. That is X_AY_B and X_BY_A are available in the market
- Consumers
  - There are three consumers, denoted by *AA*,*AB*,*BB*, with heterogeneous preferences toward systems
  - Denote p_i^x and p_i^y the prices of component *X* and Component *Y* produced by firm *i*, respectively, *i*=*A*,*B*

The Components Approach (cont')

- U_{ij} is the utility level of consumer *ij*, whose ideal system is X_iY_j, *ij*=*AA*,*AB*,*BB*
- U_{ij}= 2λ-($p_i^x+p_j^y$)if purchasing system X_iY_j
  = λ-($p_j^x+p_j^y$)if purchasing system X_jY_j
  = λ-($p_i^x+p_i^y$)if purchasing system X_iY_i
  = -($p_j^x+p_i^y$) if purchasing system X_jY_i
  = 0 if does not purchase any system

Incompatible systems

- $X_A Y_B$, $X_B Y_A$ are not feasible
- We look for a Nash-Bertrand equilibrium in prices
- There are three equilibria ($p_A = p_A^x + p_A^y$, $p_B = p_B^x + p_B^y$)
  - (1) firm *A* sells systems $X_A Y_A$ to consumers *AA* and *AB* while form *B* sells system $X_B Y_B$ to consumer *BB*.
    ($p_A = \lambda, q_A = 2$, $p_B = 2\lambda, q_B = 1$)
  - (2) firm *B* sells system $X_B Y_B$ to consumers *BB* and *AB* while firm *A* sells system $X_A Y_A$ to consumer *BB*
    ($p_A = 2\lambda, q_A = 1$, $p_B = \lambda, q_B = 2$)
  - (3) firm *A* sells system $X_A Y_A$ to consumer *AA*, firm *B* sells systems $X_B Y_B$ to consumer *BB*
    ($p_A = p_b = 2\lambda, q_A = p_B = 1$)
- In any equilibrium the firms' profit levels are given by $\pi_a = \pi_b = 2\lambda$

Compatible systems

- $X_A Y_B$, $X_B Y_A$ are feasible
- We look for a Nash-Bertrand equilibrium in prices
- There exists an equilibrium
  - Each consumer purchases his ideal systems.
  - $p_A^x = p_A^y = p_B^x = p_B^x = \lambda$
  - Firm *A* sells two component of *X* and on component of *Y*
  - Firm B sells two component of *Y* and on component of *X*
  - $\pi_a = \pi_b = 3\lambda$

Incompatible vs compatible systems

- Incompatible systems
  - $CS = \lambda$; $W = \pi_a + \pi_b + CS = 5\lambda$
- compatible systems
  - $CS = 0$; $W = \pi_a + \pi_b + CS = 6\lambda$

