Course outline II

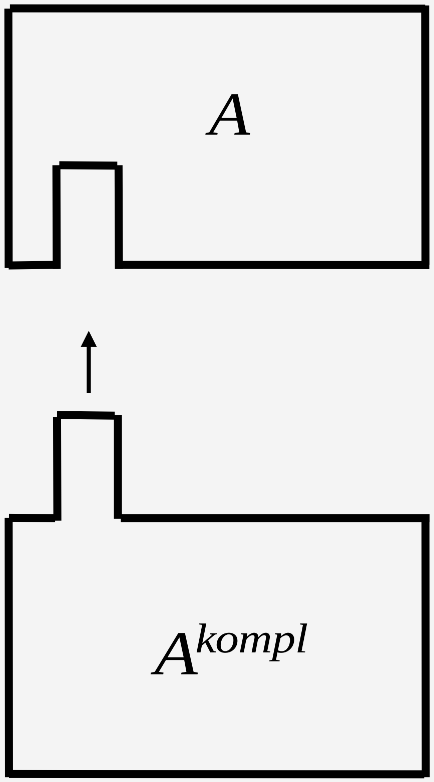
- Product differentiation
- Advertising competition
- Compatibility competition

Heterogeneous goods

Compatibility competition

- Compatibility
  - vertical and horizontal,
  - unilateral and reciprocal
- Network effects
- Competition with different degrees of compatibility
- Competition with equal degrees of compatibility
- Competition with complements
- Executive summary

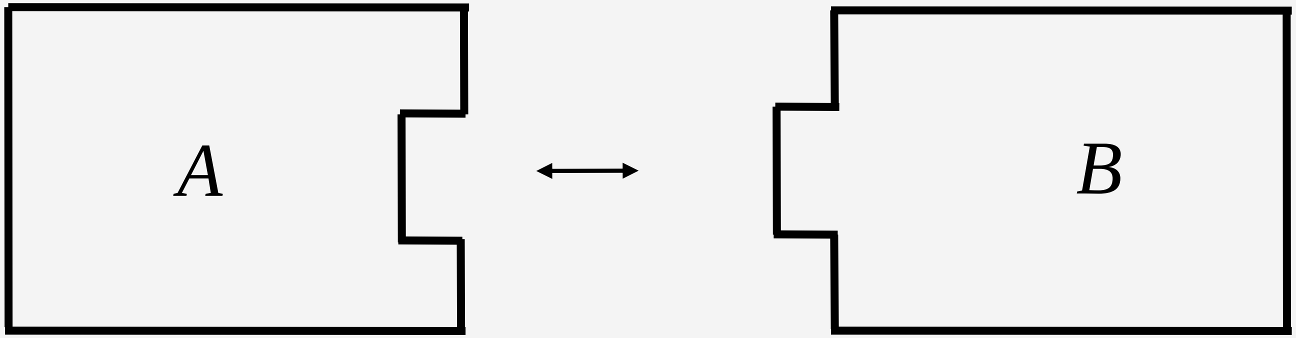
Vertical compatibility



e.g.:

- screws (A) and nuts (A^{kompl})
- coffee pads (A) and coffee machines (A^{kompl})

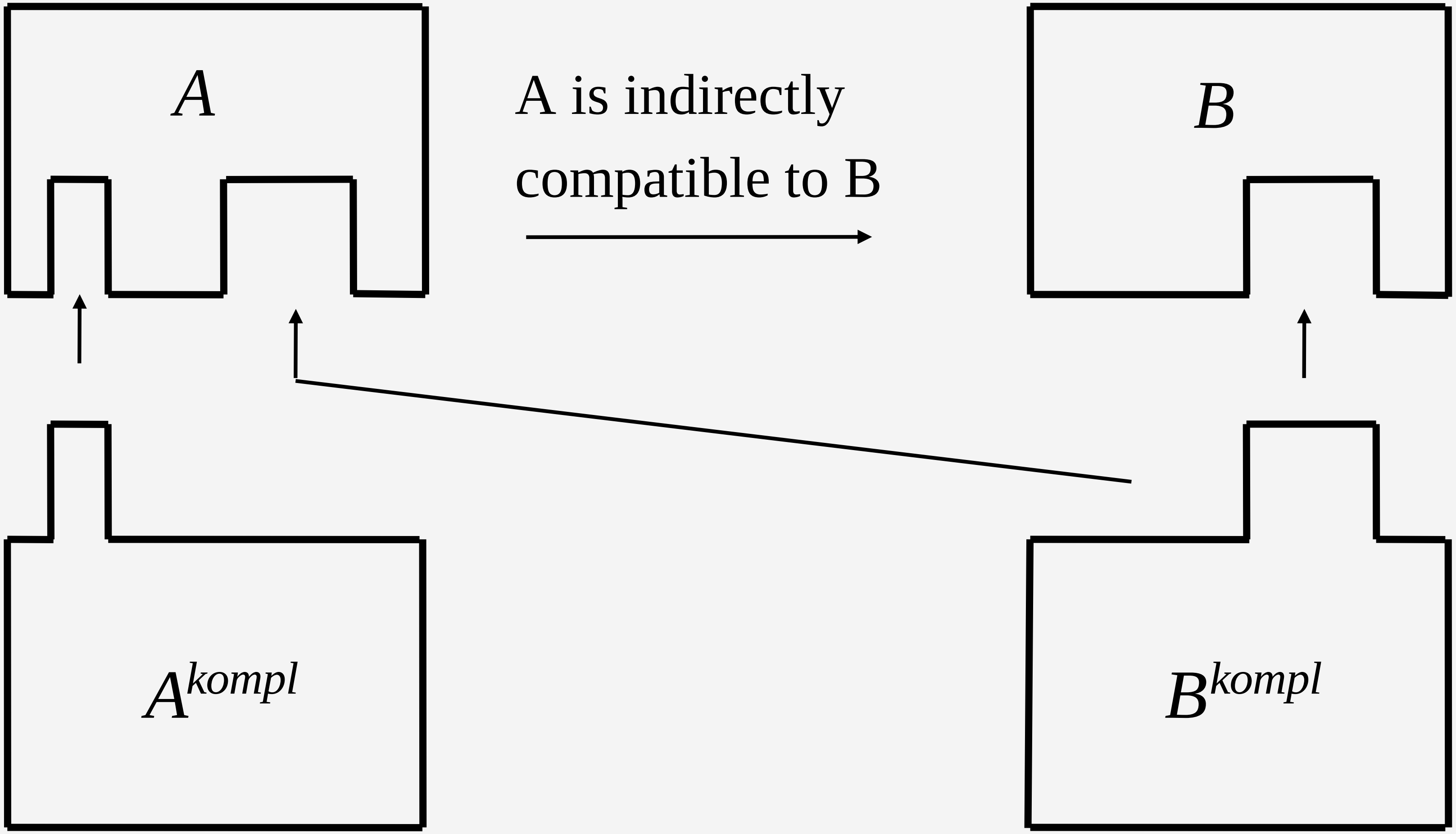
Horizontal compatibility



e.g.

- telephones from different firms

Indirect horizontal compatibility



A is indirectly compatible to B

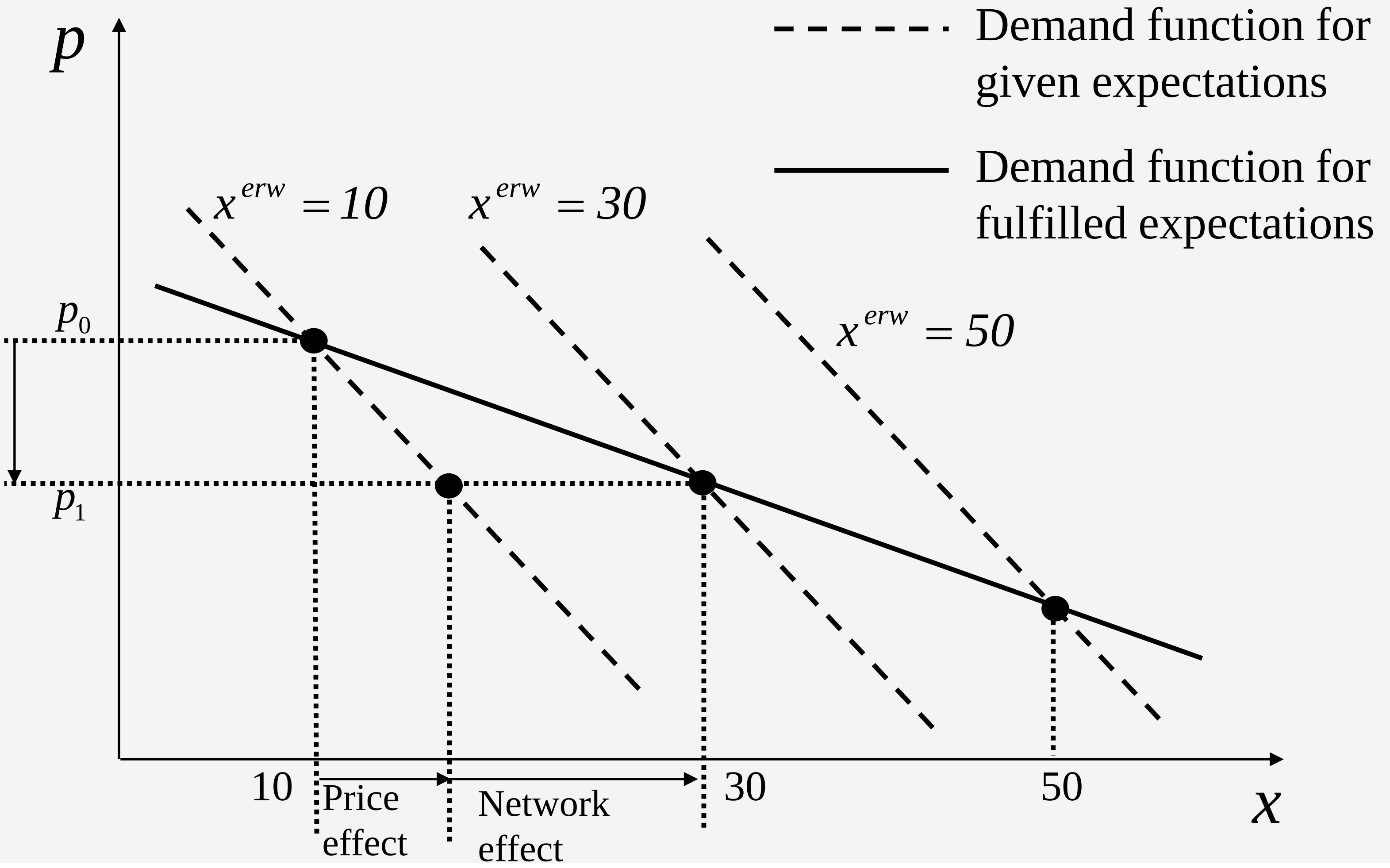
Unilateral and reciprocal compatibility

- Unilateral
  - Apple computer (sometimes) understand software designed for IBM-compatible PCs (A understands B^{kompl})
- Reciprocal
  - telephones

Network effects and compatibility

- Apple Computers are less attractive to consumers because its client base is smaller than that of Microsoft and Intel.
- Other examples:
  - Direct current versus alternating current
  - Typewriters’ keyboards
  - Cash machines

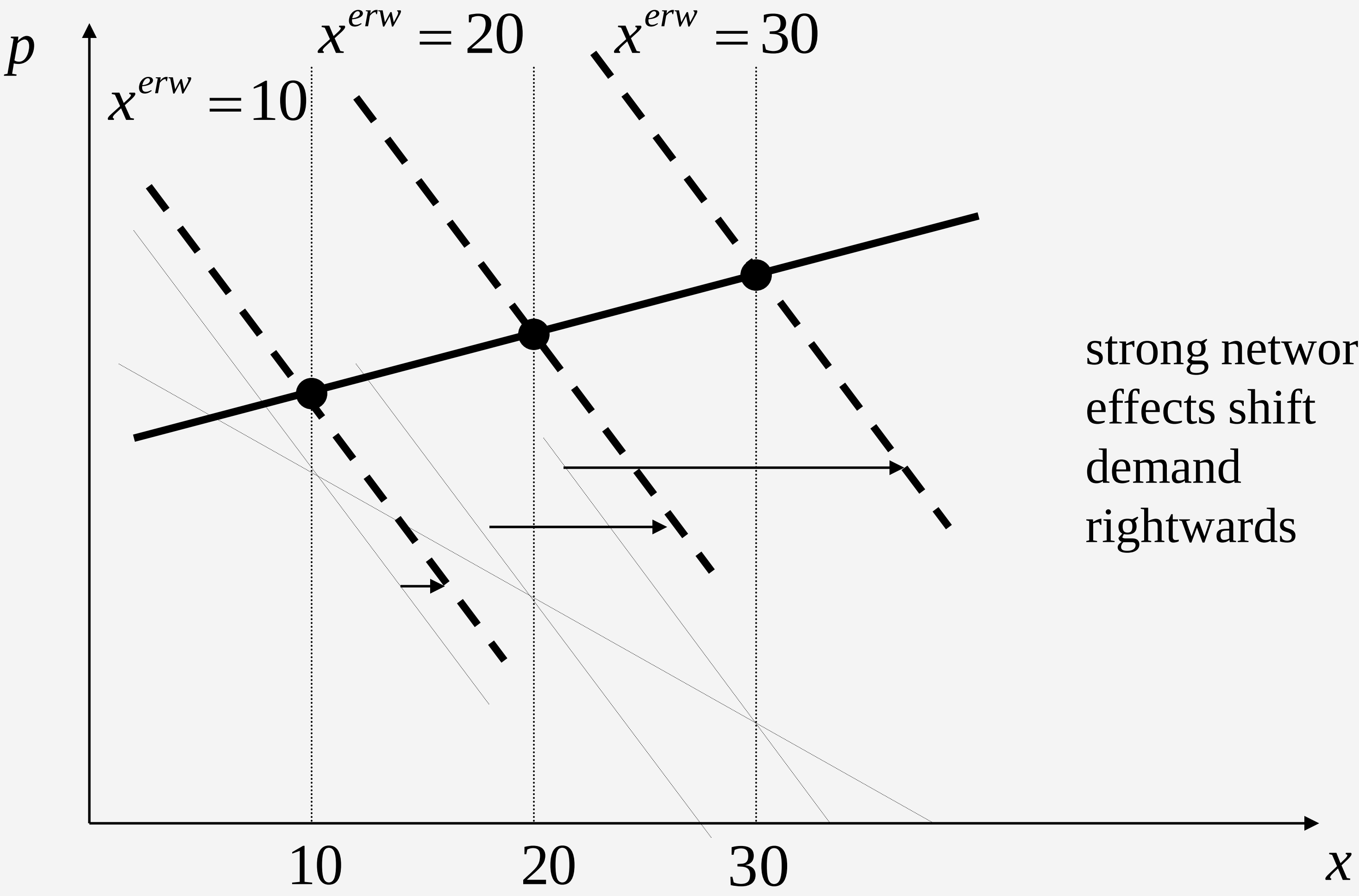
Network effects and expectations



- - - - - Demand function for given expectations

—— Demand function for fulfilled expectations

Network goods need not be ordinary



strong network effects shift demand rightwards

Exercise (Given and fulfilled expectations)

The potential consumers of a network-effect product are uniformly distributed on the interval [0,1]. Consumer h $(0 \leq h \leq 1)$ has the utility

$$U^h = \begin{cases} x^{erw}(1-h) - p, & \text{if he buys one unit,} \\ 0, & \text{otherwise.} \end{cases}$$

Calculate:

- Demand function $x(p, x^{erw})$ for given expectations.
- Inverse demand function $p(x)$ for fulfilled expectations with sketch.
- Stable and unstable points.
- Calculate a monopolist's profit-maximizing price.

S.: $p(x) = x(1-x)$ and $x^M = \frac{2}{3}, p^M = \frac{2}{9}$

Network effects and their impact for business strategies

- In case of network-effect goods the products' attractiveness depends on the number of customers.
- It may pay to build an installed base (customers that bought the product previously).
- Sometimes not the best product, but the product with largest network "wins" (Example: VHS).

Assumptions and notation

- Products are maximally differentiated.
- Degree of compatibility $0 \le s_1, s_2 \le 1$.
- Advantage of compatibility for firm 1:

  $\Delta s = s_1 - s_2$
- No cost of differentiation or compatibility
- Network strength *e*.

Network size advantage, network effect

- Network size for firm 1

$$n_1 = x_1^{erw} + x_1^{i} + s_1\left(x_2^{erw} + x_2^{i}\right) = \left(x_1^{erw} + s_1 x_2^{erw}\right) + \left(x_1^{i} + s_1 x_2^{i}\right)$$

expected demand for product 1

installed base for product 1

- Network effect $e \cdot n_i$
- Network-size advantage for firm 1

$$\Delta n = n_1 - n_2 = \Delta n^{i} + \Delta n^{erw}$$

$$\Delta n^{i} = \left(x_1^{i} + s_1 x_2^{i}\right) - \left(x_2^{i} + s_2 x_1^{i}\right) \qquad \text{base} - \text{advantage}$$

$$\Delta n^{erw} = \left(x_1^{erw} + s_1 x_2^{erw}\right) - \left(x_2^{erw} + s_2 x_1^{erw}\right) \qquad \text{expectation} - \text{advantage}$$

Demand function for given expectations

- Consumers buy product 1 if:

$$p_1^{eff} \le p_2^{eff}$$

$$p_1 + th^2 - en_1 \le p_2 + t\left(1-h\right)^2 - en_2$$

$$h \le \frac{1}{2} + \frac{1}{2t}\left[p_2 - p_1 + e\Delta n\right] =: h^* = x_1\left(p_1, p_2, s_1, s_2\right)$$

consumers in case of equal prices

intensity of competition

firm 1's price advantage

firm 1's network advantage

Demand function for fulfilled expectations

$x_1 = x_1^{erw}$ and $x_2 = x_2^{erw}$

$$\rightarrow x_1 = \frac{1}{2} + \lambda(s_1, s_2)\left[p_2 - p_1 + \frac{1}{2} e\left(2\Delta n^i + \Delta s\right)\right]$$

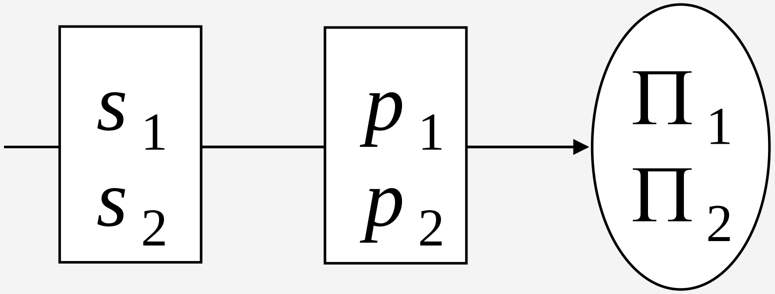
intensity of competition

firm 1's price advantage

firm 1's base-compatibility advantage

where $\lambda(s_1, s_2) = \dfrac{1}{2t - e(2 - s_1 - s_2)}$

Competition with different degrees of compatibility



- Fulfilled-expecations profit functions:

$$\Pi_1 = (p_1 - c)x_1(p_1, p_2, s_1, s_2)$$

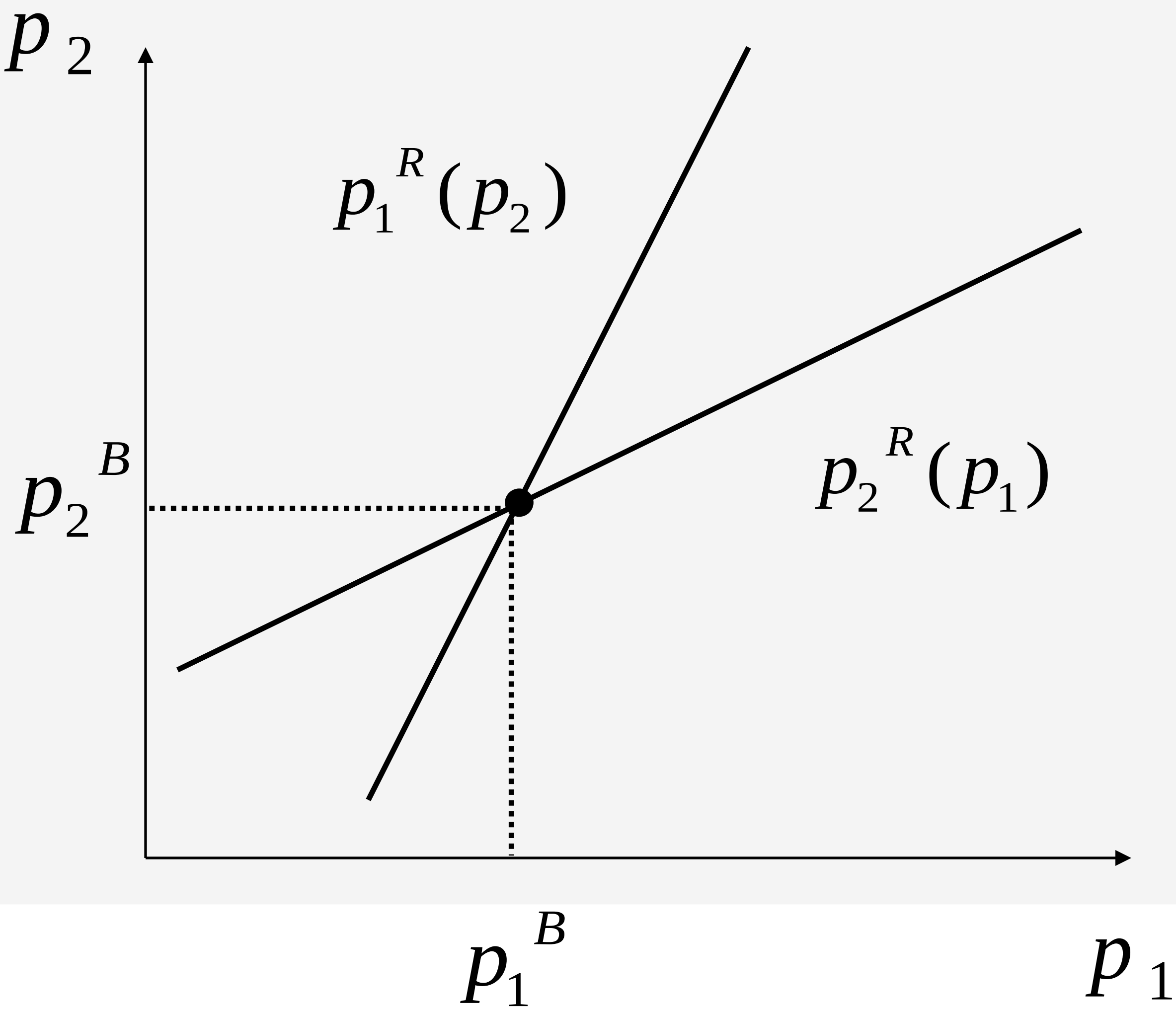
$$= (p_1 - c)\left(\frac{1}{2} + \lambda(s_1, s_2)\left[(p_2 - p_1) + \frac{1}{2}e\left(2\Delta n^i + \Delta s\right)\right]\right)$$

$$\Pi_2 = (p_2 - c)\left(\frac{1}{2} - \lambda(s_1, s_2)\left[(p_2 - p_1) + \frac{1}{2}e\left(2\Delta n^i + \Delta s\right)\right]\right)$$

Price reaction functions

- $$p_1^R(p_2) = \arg\max_{p_1} \Pi_1(p_1, p_2)$$
  $$= \frac{1}{2}\left(p_2 + c + \frac{1}{2\lambda} + \frac{e}{2}\left(2\Delta n^i + \Delta s\right)\right)$$
  $$p_2^R(p_1) = \frac{1}{2}\left(p_1 + c + \frac{1}{2\lambda} - \frac{e}{2}\left(2\Delta n^i + \Delta s\right)\right)$$
- High prices in case of
  - high installed base
  - high advantage of compatibility
  - compatible and differentiated products

Price reaction functions - graphically



Pricing game (different degrees), 2nd stage

- Equilibrium

$$p_1^B = c + \frac{1}{2\lambda} + \frac{e}{6}\left(2\Delta n^i + \Delta s\right)$$

$$p_2^B = c + \frac{1}{2\lambda} - \frac{e}{6}\left(2\Delta n^i + \Delta s\right)$$

- Equilibrium outcomes

$$x_1^B(s_1, s_2) = \frac{1}{2} + \frac{1}{6} e\lambda\left(2\Delta n^i + \Delta s\right)$$

$$\Pi_1^B(s_1, s_2) = \frac{1}{36} \frac{\left(3 + e\lambda\left(2\Delta n^i + \Delta s\right)\right)^2}{\lambda}$$

Compatibility game, 1st stage

- Equilibrium (difficult to ascertain!)

$$s_1^N = s_2^N = 1$$

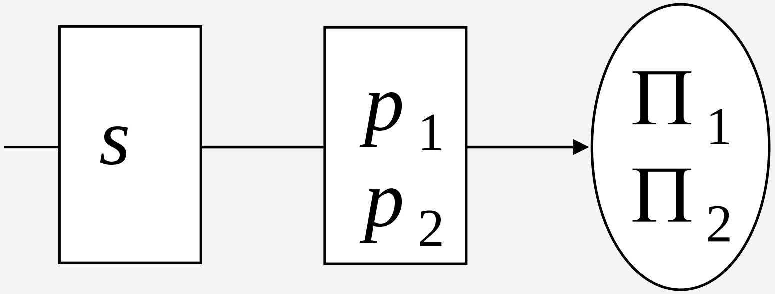
- Further results

$$p_1^B = p_2^B = c + t$$

$$x_1^B = x_2^B = \frac{1}{2}$$

$$\Pi_1^B = \Pi_2^B = \frac{1}{2} t$$

Competition with equal degrees of compatibility



- $s = s_1 = s_2$ (e.g. HDTV or GSM)

$$\rightarrow \Delta n^i = \left(x_1^i + s_1 x_2^i\right) - \left(x_2^i + s_2 x_1^i\right) = \left(x_1^i - x_2^i\right)\!\left(1 - s\right)$$

$$\rightarrow \Delta s = s_1 - s_2 = 0$$

$$\rightarrow \lambda = \frac{1}{2t - e\left(2 - s_1 - s_2\right)} = \frac{1}{2\left(t - e\left(1 - s\right)\right)}$$

Pricing game (1st stage) and compatibility game (2nd stage)

- Equilibrium (1st stage)

$$p_1^B(s,s)=c+\frac{1}{2\lambda}+\frac{e}{3}\Delta n^i \text{ and } p_2^B(s,s)=c+\frac{1}{2\lambda}-\frac{e}{3}\Delta n^i$$

- Equilibrium outcomes (1st stage)

$$x_1^B(s,s)=\frac{1}{2}+\frac{1}{3}e\lambda\Delta n^i$$

$$\Pi_1^B(s,s)=\frac{1}{36}\frac{\left(3+2e\lambda\Delta n^i\right)^2}{\lambda}$$

- Results 2nd stage: Assuming $\Delta n^i>0\ (x_1^i>x_2^i\ \ and\ \ s<1)$
  - small firm prefers s=1
  - firm with high base advantage prefers s=0

Competition with different degrees of compatibility - Entry deterrence I

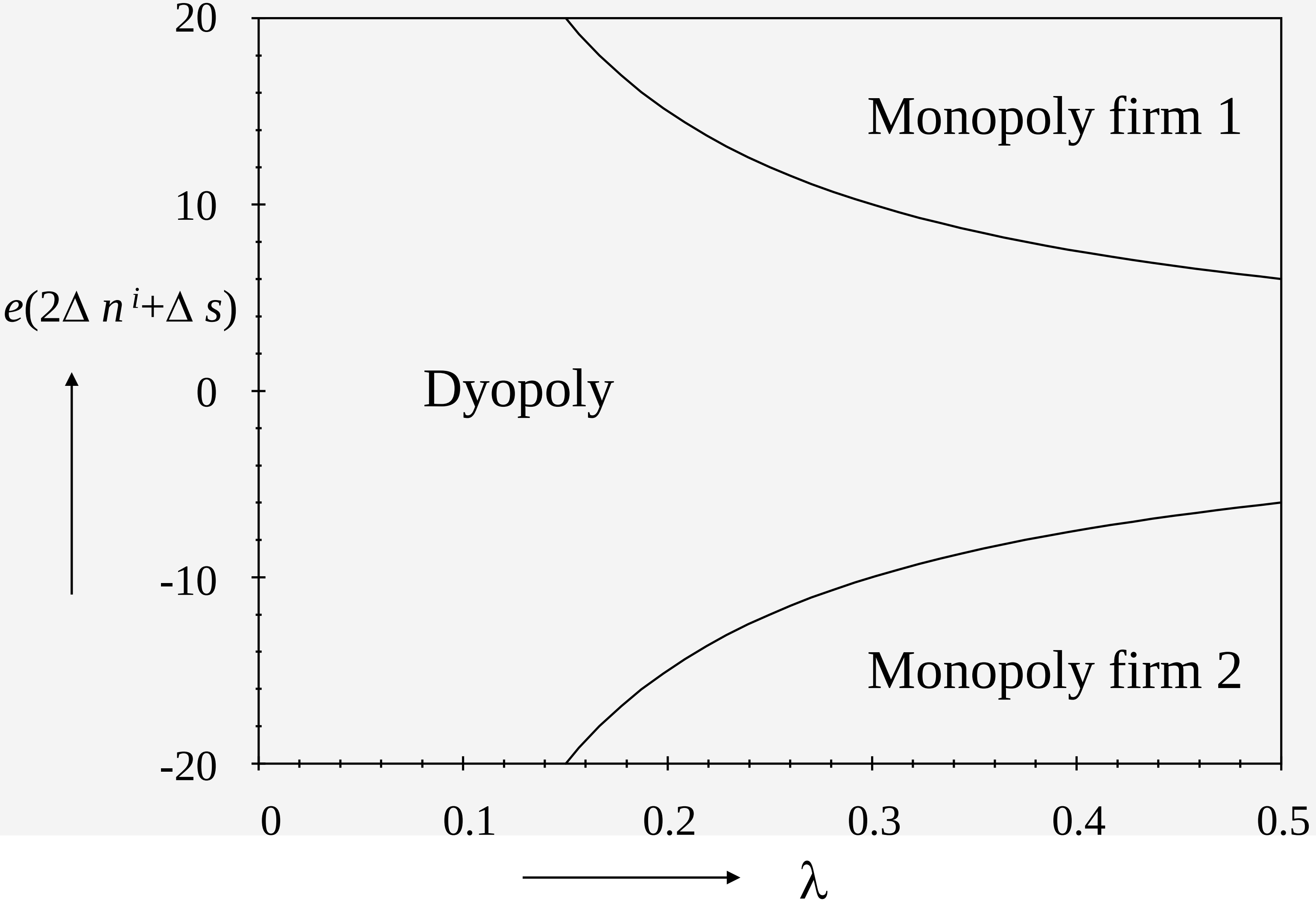
$$x_2^B(s_1, s_2) = \frac{1}{2} - \frac{1}{6} e\lambda\left(2\Delta n^i + \Delta s\right) \leq 0$$

$$\Leftrightarrow \underbrace{e\left(\underbrace{2\Delta n^i + \Delta s}_{\text{Base compatibility advantage}}\right)}_{\text{Valuated base compatibility advantage}} \geq \frac{3}{\lambda} = 3\left(2t - e\left(2 - s_1 - s_2\right)\right)$$

$$\Rightarrow \frac{3}{\lambda e} \ \text{limit base compatibility advantage}$$

$$\Rightarrow x_1^i \geq \frac{3\frac{t}{e} - \left(3 - 2s_2 - s_1\right) + x_2^i\left(1 - s_1\right)}{1 - s_2} \quad \text{(limit base)}$$

Competition with different degrees of compatibility - Entry deterrence II



Competition with complements

- General Motors founded 1919 the „General Motors Acceptance Corporation“.
- Telecommunication firms offer telephone connections and mobiles.

Exercise (bundle)

A monopolist sells a bundle ...

$x_1(p_1, p_2)=100-p_1-p_2$

$x_2(p_1, p_2)=100-p_2-p_1$

Unit costs are constant at $20.

a) Profit-maximizing prices?

b) Now assume there are two monopolists selling the components independently.

S.: $a)\ p_1 + p_2 = 70$

$b)\ p_1 + p_2 = 80$

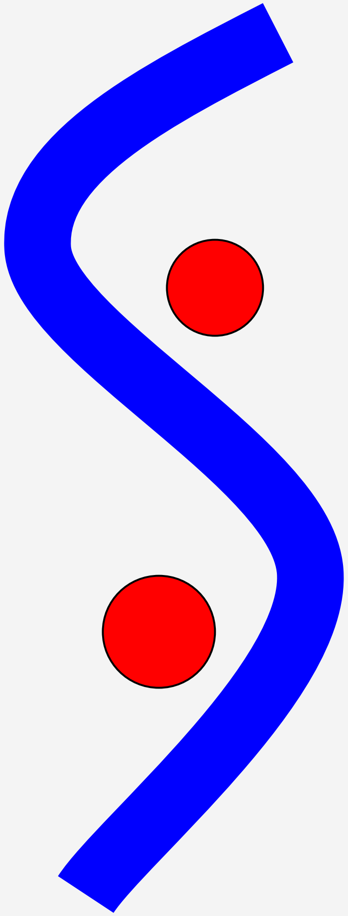
The Microsoft case: What happened

- Judge Thomas Penfield Jackson issued his final judgment in the antitrust case against Microsoft (Plaintiff: USA, Defendant: Microsoft Corporation) in June 2000.
- Microsoft shall submit a proposed plan of divestiture. The Plan shall provide for ... [the] separation of the Operating Systems Business from the Applications Business.

Krugman‘s parable (New York Times, April 26, 2000)

- „Baron Wilhelm von Gates was the lord of two castles, each commanding a strategic bottleneck along the Rhine. From these castles he was able to demand money from all the travelers who passed by. ... Eventually the Holy Roman Emperor ... split up the Gates domain, giving one of the castles to the baron‘s nephew.“
- Result: „Not only did [travelers] now face the nuisance of dealing with two different robber barons, but they said they were paying more for each trip than they had before.“

Illustration - complements



$$\frac{\partial \Pi_1^B\left(p_1, p_2^B\right)}{\partial p_1} \overset{!}{=} 0$$

$$\frac{\partial \Pi_2^B\left(p_1, p_2^B\right)}{\partial p_1} < 0$$

What do you think?

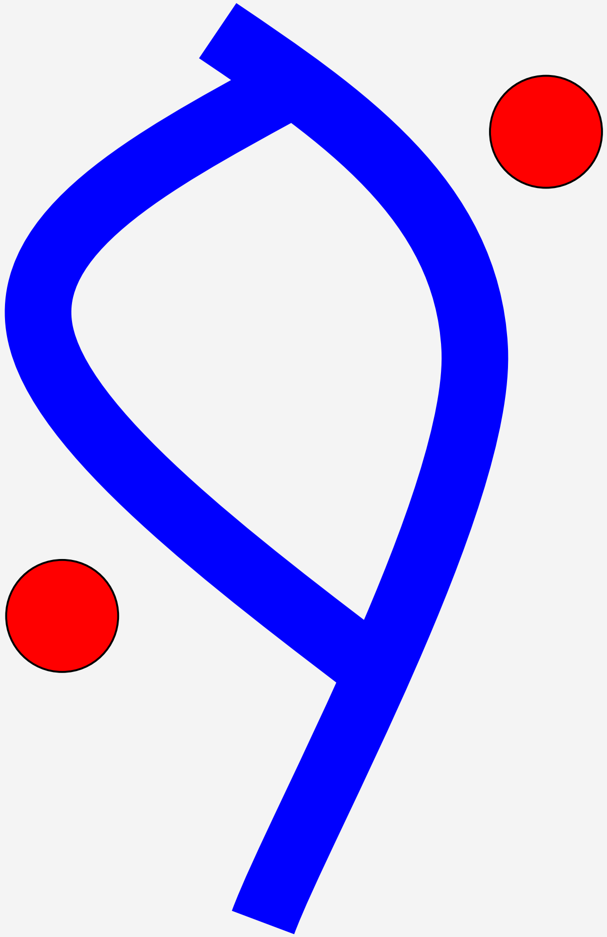
- Operating systems and applications are complements, like the two castles.
- After the breakup, positive externalities going from one castle to the other, from the operating systems business to the applications business, cannot be internalized any more.
- Prices go up, but profits go down.

Appeals court reverses Microsoft breakup order (June 2001)

- Although the U.S. Court of Appeals for the District of Columbia found that Microsoft engaged in illegal conduct in order to maintain its operating system monopoly, it ruled that Judge Thomas Penfield Jackson created an impression in out-of-court comments that he was biased against the company.
- The court's…opinion…means the case now goes back to a different District Court judge for further proceedings.

Source: http://www.computerworld.com

Illustration - substitutes



$$\frac{\partial \Pi_1^B\left(p_1, p_2^B\right)}{\partial p_1} \overset{!}{=} 0$$

$$\frac{\partial \Pi_2^B\left(p_1, p_2^B\right)}{\partial p_1} > 0$$

Executive summary I

- Solving the start-up problem / Entering into a market with network products
  - Vapor ware (non-realized sales, channel stuffing)
  - Preannouncement
  - Low prices for pioneer customers
  - Low prices for targeted groups (students)
  - Product differentiation
  - (Unilateral) compatibility

Executive summary II

- Dominating a network effect market
  - Aggressive price policy
  - Homogeneous products (except compatibility)
  - Compatibility with old own products
  - Incompatibility with competitor?
- Complementary goods
  - Develop a joint price strategy with producers of complements
  - Offer complements together with your origin product (bundles)