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Lecture 26

Networks & technological standards

Industrial Economics

Network externalities

- In microeconomics, ***demand*** for a product is derived by the ***utility*** this product yields to consumers
- A ***silent hypothesis*** in this approach is that consumer utility depends only on ***own consumption*** of the good
- This analysis ignores possible ***externality effects***
  - telephone, fax, VCR, game consoles, smoking, fashion
- A network externality occurs when the ***value*** of a product to ***any*** consumer increases with the ***number of consumers*** using the product
  - purchase by an additional consumer raises the value of the product ***for all*** consumers

Direct and indirect network effects

- A network effect is direct when the externality pertains to the ***good itself***
  - more people join ***WhatsApp***, the higher its value for all users
- A network effect is indirect when the externality is mediated by a ***complementary good***
  - the value of ***Xbox*** for gamers increases as more game developers produce compatible games

Network model

- Consumers can have access to a ***service*** with no close substitutes for a ***fixed fee*** p
- N is the maximum ***number of consumers***
  - those who would access the service if $p = 0$
- For each consumer $i \in N$, the ***valuation*** of the good when $p = 0$ is

$$v_i \sim uniform(0, \bar{v})$$

  - that is, how much i ***would pay*** for the service if i knew that ***everyone else will join***, too
- f_e is the ***fraction*** of the N consumers who is ***expected*** to choose to access the service at the ***given*** p

Network monopoly

Decision to join

- Consumer ***demand*** will be

$$q_i = \begin{cases} 0 & if \quad f_e v_i < p \\ 1 & if \quad f_e v_i \geq p \end{cases}$$

- ***Willingness to pay*** is the expected fraction of usage multiplied by the valuation at the maximum usage
  - notice that willingness to pay ***increases*** with f_e
- Consider the ***marginal consumer*** for price p to be v_p, so that at p, $v_p/\bar{v}$ consumers ***do not*** acquire the service
- Thus the fraction who ***will acquire*** the service is

$$f = 1 - \frac{v_p}{\bar{v}} = 1 - \frac{p}{\bar{v} \cdot f_e}, \qquad \text{because} \quad f_e v_p = p$$

Demand

- We can ***solve*** the previous relationship w.r.t. p

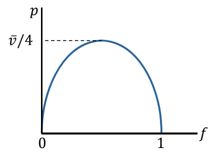
$$p = \bar{v} f_e (1 - f)$$

- Assuming ***rational expectations*** at equilibrium $f = f_e$ thus:

$$p = \bar{v} f - \bar{v} f^2 \quad (1)$$

- According to (1) ***no equilibrium price*** exists above $\bar{v}/4$

  that is, the network will ***not be sustainable*** for $p > \bar{v}/4$



Network failure example

- Consider ***some network*** with $\bar{v} = 100$ and $f = 0.5$
- According to (1) the ***max price*** for this network is 25
- What if $p = 30$?
  - The ***average*** v_i for top 50% of users is $(50 + 100)/2 = 75$
  - ***Willingness to pay*** for top 50% of users is $0.5 \cdot 75 = 37.5$
  - But $p = 30 < 37.5$
  - The network is ***efficient*** but still ***fails*** – this is a ***paradox***!

Paradox explanation

- The ***average*** willingness to pay is indeed more than 30
- However, there are ***some consumers*** who are ***not*** willing to pay 30 or above

  specifically, those with $v_i \in [50{,}60)$ have willingness to pay lower than 30 when $f = 0.5$

- Those consumers will ***leave*** the market ***dropping*** f to 0.4

  at $f = 0.4$, those with $v_i \in [60{,}75)$ will ***abandon*** the market ***dropping*** f further to 0.25

- This will ***continue*** till the network ***fails*** $(f = 0)$

Equilibria

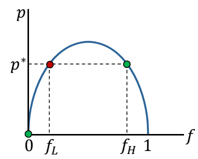
- If ***fixed*** setup ***cost*** for a network with ***capacity*** N is F

  zero MC

- The ***total profit*** for the seller is $\Pi = (\bar{v} f - \bar{v} f^2) f N - F$
- The ***FOC*** (with respect to f) is

$$2\bar{v} f - 3\bar{v} f^2 = 0$$

- There are ***3 equilibria*** for f:
  - The trivial equilibrium $f = 0$,
  - A low equilibrium f_L and
  - A high equilibrium f_H



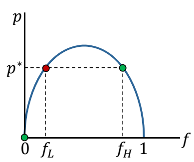
- Notice that both f_L and f_H will yield the ***same price***

An interesting property of stability

- In 1974, ***Jeffrey Rohlfs*** noticed an interesting property of this set of equilibria

  he observed that the f_L equilibrium was ***unstable***

- ***If*** $f = f_e = f_L$ the network would ***equilibrate***
  - If however users expected $f_e > f_L$, this would cause $f > f_e$, which in turn ***would increase*** f_e further, till $f = f_e = f_H$
  - On the contrary, if users expected $f_e < f_L$, this would cause $f < f_e$, which in turn ***would decrease*** f_e further, till $f = f_e = 0$



- This is similar to the ***W-boul*** experiment

Critical mass

- f_L is the ***critical mass*** that the network needs for ***liftoff***

  networks that ***do not reach*** f_L are not just smaller – they ***completely fail***

- ***How*** can the monopolist reach critical mass?
  - Provide the service ***free*** when the network is ***new*** (WhatsApp, Tinder)
  - ***Bundle the service*** together with some established product (IE, Netflix, Chrome)
  - ***Hire*** some critical mass (PR agencies, clubs, star-consumers)
  - Market the network on ***smaller target groups*** first (Facebook, fax machines)

Competition between networks

- Assume that network A and network B ***compete*** over a ***homogeneous*** service
- Consumers will join the network that yields the ***higher surplus***

$$f_A v_i - p_A \quad \text{vs} \quad f_B v_i - p_B$$

- In this case one possible ***stable equilibrium*** will be

$$f_A = f_B = f_H/2$$

- Equilibrium ***price*** will be $p_A = p_B = MC$
  - Decreasing price leads to higher share but ***loses***
  - Increasing price leads to lower share and ***loses***

Heterogeneous services – benchmark

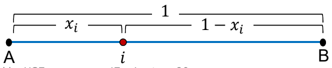
- A and B sell two ***differentiated*** goods produced at marginal ***cost*** c – no externalities
- Consider ***consumer*** i at preference ***distance*** x_i from A
- ***Surpluses*** for i:

$$V - tx_i - p_A \quad \text{and} \quad V - t(1 - x_i) - p_B$$

where V is the ***utility*** from consumption and t is ***intensity of disutility from differentiation***

- At ***equilibrium*** of this ***linear location model***

$$p_A = p_B = c + t$$



Heterogeneous services – networks

- Now consider the same market with ***network effects***
- Consumer ***surpluses*** are

$$V - tx_i + kf_{Ae} - p_A \quad \text{and} \quad V - t(1 - x_i) + kf_{Be} - p_B$$

  - Where f_{Ae} and f_{Be} are the ***market shares*** for A and B that consumer i ***expects***
  - Also, $0 < k < t$
- At ***equilibrium*** the expected market share will be equal to the actual so that

$$f_{Ae} = x^* \quad \text{and} \quad f_{Be} = 1 - x^*$$

- Thus, at ***equilibrium***

$$p_A = p_B = c + t - k$$

The impact of network effects

- Comparing the two outcomes, becomes clear that price competition is ***tougher with network effects***
- The value of ***acquiring an extra customer*** from the rival in now ***enhanced***

  it increases ***willingness to pay*** for all existing consumers

- In this manner, the market may become "***tippy***" and end up becoming a "winner-take-all" game
- Once a side starts ***losing customers***, the value of the network to the remaining customers falls, causing it to ***lose more customers***

  this will continue till the ***network is obliterated***

In-Lecture question

Does the parabolic demand for a network violate the law of demand?

(♥) YES, because it includes an increasing segment

(♥) NO, because in the x-axis there is f, not q

(♥) NO, because there is the assumption that purchasing decision depends on the decision of other consumers

(♥) Both (♥) and (♥) are correct

VOTE COMPLETED!
PUT PHONES AWAY
LECTURE CONTINUES

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Path dependence

- Assume ***two networks***, A and B, offered to users

  55% of users ***prefers*** A to B when the two networks are used by the same amount of users

- It is ***possible*** that out of say 100 first adopters, 65 opt for B and only 35 opt for A
  - This might mean that out of mere luck, B may have become ***more attractive*** for the ***next wave*** of adopters
  - Even if the next wave of users prefer A on average, they could ***select B*** if it already has ***sufficiently more users***
  - Future waves of new users face a ***lock-in effect*** for B
- B prevails due to ***path dependence***

  A's advantage was ***overcome*** by the initial random path

Case study

* In 1993 a bunch of undergrads from University of Illinois created ***Mosaic***, the first internet browser
  - the app was offered for ***free*** and got serious ***traction*** within months
* A year later the Mosaic team was ***hired*** at Silicon Valley
  - they could not use the mosaic code due to ***copyright*** restrictions so created a newer and faster version: the project was named "***mozilla***" (mosaic killa!)
* In 1994, they launched the ***Netscape Navigator*** which became an instant hit
  - within a year the company was ***worth $2B*** and was the one who kick-started the "dot-com" bubble

Internet Explorer

* On their side, ***Microsoft*** was ready to launch ***Windows 95*** when it realized the potential of the browser as a tool
* Microsoft went to U of Illinois and ***licensed Mosaic***
  - within a year were able to turn it into ***Internet Explorer*** and bundled it into Windows 95 at no extra cost
* Microsoft also proceeded to ***agreements of exclusivity***
  - With PC manufacturers to not preinstall Netscape
  - With ISPs to not support Netscape as good as IE
* Netscape navigator quickly started to ***lose market share*** even though their product was ***superior*** to IE

Litigation

* In 1998 the US Justice Dept. filed one of the largest ***antitrust actions*** in history
  - Microsoft was accused for taking ***advantage of its dominant position*** in the market of operating systems to monopolize the market of browsers and ***predation***
* In 2001 the ***court ruled*** that Microsoft should
  - ***Pay $750M*** to AOL who had acquired Netscape (for $4.2B)
  - ***Share the OS interface*** with 3rd party browser developers
* The ***final act*** of Netscape before AOL gets the keys was to open-source the Mozilla code

15 years later

Today more and more people see ***merit*** in Microsoft's actions and claims

1. From the beginning, Microsoft argued that ***the future*** required the browser to be ***integrated*** to the OS
   - today there is no doubt that this was ***indeed the case***
2. Microsoft was accused for ***predation***
   - from our model it is clear that under network competition what may look like predatory behavior when applied in other markets is really just ***normal competition*** when applied in a setting of network goods…

15 years later (cont'd)

3. Microsoft was accused for intending to ***exploit*** the browser market
   - It never did – today it is clear that browsers are not meant to be ***standalone products*** and they are all ***free***

* Microsoft was asked to pay another $800M for a similar antitrust case on its ***Media Player*** by the EU in 2004

Industrial standards

* When more than one networks prevail, ***compatibility*** may become important
  - To ***what extent*** will the industry adopt a ***standard*** that enables consumers to "plug in" to any network?
  - ***Phone networks*** have to be compatible, ***railroad tracks*** have to have the same width – ***printing paper*** the same size
* Firms have to ***negotiate*** over compatibility standards
  - since firms have invested in their own technologies, they have reasons to ***push their own*** system as the ***standard***
* ***Fights*** over standards are usual
  - VHS vs. Betamax, QWERTY vs. Dvorak, CD vs. Digital compact cassette, HD DVD vs. Blue Ray, USB-c vs. Lightening

Standard adoption

- ***How*** industries come about tech standards?
- Assume that ***two*** firms have to decide on whether to ***stick*** with their technology ***or switch*** to that of the other firm
- Lets examine different cases of ***negotiation***

"Sidewalk" adoption

Firm A		Firm B: Tech A	Firm B: Tech B
	Tech A	5 , 4	3 , 2
	Tech B	3 , 3	4 , 7

- Both companies prefer ***compatibility***
- Each company prefers the ***other to come over***
- Adoption of B can easily be achieved with the ***right negotiation tactic***

"Pesky little brother" adoption

Firm A		Firm B: Tech X	Firm B: Tech Y
	Tech X	12 , 4	16 , 2
	Tech Y	15 , 2	10 , 5

- Here there is ***no "own"*** technology
- Assume that ***A is the leader***
  - If A selects *Y*, B will ***imitate***;
  - If A selects *X*, B will again ***imitate***;
- A wants ***exclusivity*** while B wants ***compatibility***
- A can defend by either ***patenting*** the technology they pick or by ***switching*** technologies often

Thank you!

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