Economics of Strategy for Online and Digital Markets

Topics in Economic Theory and Policy, 31C01000

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Lecture 8: Networks

Outline

- Networks
- Network effects
- Model of fulfilled expectations

Figure. Photo of Wynn Wagner III.

Figure: Religion Wiki.

Example of a listing: `Compost, 914-720 497, V.21, 24H`.

Figure: infostory.com.

Mark Davis was walking east on Wilshire Boulevard — smiling. He had a few minutes to kill between lunch and launching a quarter-million-dollar electronic parts deal with a Singapore distributor.

He'd been talking about how he managed to pull off the "deal of a lifetime." A corporate coup. His self-proclaimed "corporate guerilla army" fought off several bids from multinational companies. But he had an ace in the hole: a PC-based bulletin board system (BBS).

Davis recalled the part his company's BBS played: "We had an in-house Fidonet BBS set up for communications between our L.A. office and our two-man advance team in New York. We'd used it for about a year to overcomc the bicoastal time zone hassle. No telephone tag.

"When we moved the New York team to Singapore, the first thing they did was set up a similar Fidonet BBS. The Singapore BBS and the one here automatically exchanged messages each night."

Source: InfoWorld 22 Aug 1988.

Network business – it's the 1990s

- American Online (AOL) is an example of a network business:
  - The roots of the company are in the 1980s when it was providing online services via a modem link.
  - In 1995, the company had roughly 5 million subscribers.
  - The following year AOL opened dial-up internet connection, and went on to reach 20+ million customers by 2000.
  - America Online agrees to purchase Time Warner for $165 billion in what would be the biggest merger in history.
- A quote from an analyst:
  "*The dot-com guys have sort of won*" (NYT, 11 Jan 2000).

Network business – it's the 1990s

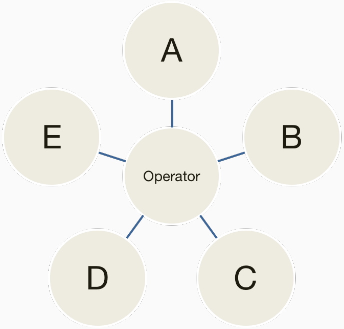
- The basic idea was simple and powerful:
  - In some cases a service is more valuable if more customers are using it because customers want to interact with each other.
  - If a firm moves fast and gets some customers, those customers will attract more customers, which will attract even more.
  - As a result, growth will be explosive and result in a single firm owning the market forever.
  - The winner would take all.
- These interrelated customers are called a network, and the feedbacks between customers are called network effects.

Network business – it's the 1990s

- The first dotcom boom crashed in 2000, wiping out much of the expected valuations of internet companies.
- AOL's growth stopped around the same time, its dial-up subscription service lost to broadband internet.
- Clearly, the network model was not working in all cases.
- We still need to understand it to be able to discuss what went wrong; and the basic logic is still valid in many examples.

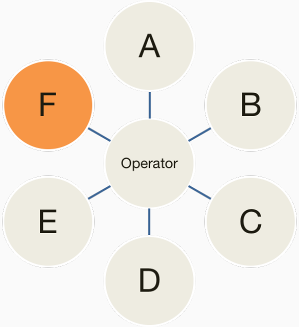
Traditional networks

In a traditional network, network externalities arise because a typical subscriber can reach more subscribers in a larger network.



Traditional networks

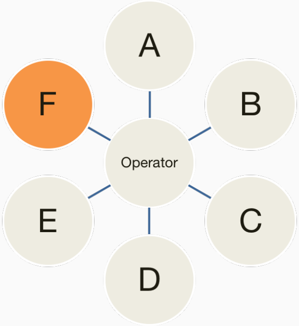
- The number of potential transactions increases with network size.
- If every new transaction has positive value, a larger network gives higher value to a subscriber.



Complementarities

Links from subscribers to the operator are used as complements:

- Enabling connection F–A through the operator enables also connections F–B, . . . , F–E.



Traditional goods: The law of demand

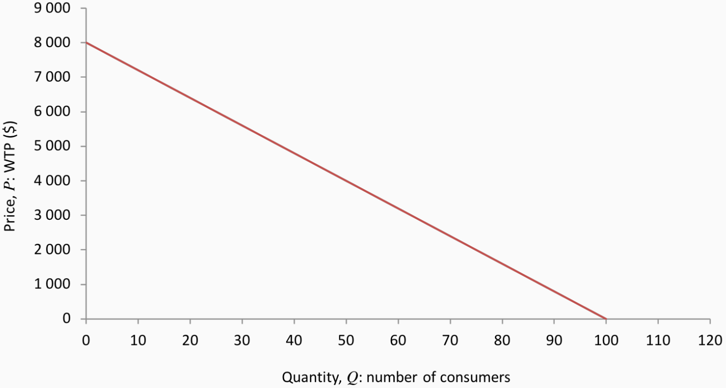


Figure. In traditional non-network industries, the willingness to pay for the last unit of a good decreases with the number of units sold.

Source: CORE.

Network effects

- The existence of network positive effects implies that, as sales expand, people are willing to pay more for the last unit.
- The key reason for the appearance of network effects is the complementarity between network components.
- Depending on the network, the network effect may be direct or indirect.

Direct network effects

- When customers are identified with components, the network effect is direct.
- Consider for example a typical two-way network, such as the local telephone network, with n subscribers:
  - There are $n(n-1)$ potential goods, i.e. potential connections from subscriber i to everyone else and back.
  - An additional customer, $(n+1)$, provides direct network effects to all other customers in the network.
  - It adds $2n$ potential new goods through the provision of a complementary link to the existing links.

Indirect network effects

- Indirect network effects involve economies of scale.
- For example, in a credit card network:
  - A user does not directly gain if one more person has the same credit card.
  - But the additional person will encourage more merchants to accept a credit card.
  - From a cardholder's perspective there is more choice and variety of merchants accepting this card.
- Many such complements exists, e.g. hardware and software.

In-class exercise: Network effects

- We will play several rounds.
- In each round, you will have to decide whether or not to buy a commodity.

In-class exercise: Network effects

- The price of the commodity for everyone is $p_0 = 6$ € throughout the exercise.
- The value of the commodity to you in a given round is determined by two things: its maximum value to you and the number of people other than you that buy it.
- The maximum value of the commodity to you is given by alphabet ordinal number of the first letter in your first name ($A = 1$, $B = 2$, $\ldots$), use a proxy if needed.
    - Write it down to a separate piece of paper.

As an example, the maximum value for Iivo is 9 € .

In-class exercise: Network effects

- The actual value of the commodity to you is equal to its maximum value multiplied by the proportion of people other than you that buy it.
- So the actual value is always lower than the maximum value unless everyone else buys the commodity.
- The actual value is zero if no one else buys the commodity.

As an example, if 12 out of the other 20 buy the commodity, then the actual value for Iivo is $12/20 \times 9 = 5.4$ €.

In-class exercise: Network effects

- At the start of each round, you either *Do Not Buy* or *Buy*.
- After everyone has decided, you will be told the share of people who bought the commodity.
- You can then calculate your actual value.
- And your profit, as follows:
  - If your decision is *Do Not Buy*, your profit is zero.
  - If your decision is *Buy*, your profit is equal to the actual value of the commodity to you, minus its price.
- Write down your maximum value, decision, your actual value, and the profit on your score card (do not pass this along).
- Update of the maximum values: Pass the paper with maximum value to the person on your left.

Network effects

- Take 1000 people who are in a market for a network good.
- Index the people from $v = 1, \ldots, 1000$. v can be thought to be the reservation price or willingness-to-pay for the good.
- Now assume that the value of the good to person v is vn, where n is the number of subscribers to the network.
- If price is set at p, then some individual, $\hat{v}$, is indifferent between buying and selling: $p = \hat{v}n$.
- Number of people with $v \geq \hat{v}$ is $n = 1000 - \hat{v}$. Combining these we get the following equilibrium prices:

$$p = (1000 - n)n$$

Network effects

Figure. Equilibrium price as a function of people choosing subscribing to the network.

Reminder: Network effects

- To see how the demand curve forms, take the network effects with the people indexed from $v = 1, \ldots, 1000$.
  - In the in-class exercise of lecture 8, this would correspond to the maximum value.
- Assume that the actual value for person v will depend on the number of people in the network, vn.
  - Likewise, this would be to the actual value.

Reminder: Network effects

- Consider what happens when only the person with highest maximum value, $v = 1000$, decides to join:
  - Because her/his valuation is the highest, no one else will join. The actual value from the network will be zero.
- If the 2nd highest valuation person, $v = 999$, also joins, then
  - The actual value for her/him is still low (999) because the 2nd person can only connect to 1 other person.
- When the 11th highest valuation, $v = 990$ joins
  - The actual value is much higher (9,900), because the network already has 10 others to connect to.
- At some point (v = 501 to be exact in this case), the decline in maximum value starts to dominate the benefits from increasing network size.

Network effects

- But to which equilibrium will the market end up?
  - The fulfilled expectations formulation (Katz and Shapiro, 1985) gives one possibility.

Model of fulfilled expectations

- Let n^e to denote consumer expectations on the number subscribers to the network service.
- $v(n; n^e)$ denotes the value for the nth buyer when n^e units are expected to be sold.
- Properties of the value function $v(n; n^e)$:
  - $v(n; n^e)$ is a decreasing function of n because the demand slopes downward (as normal).
  - $v(n; n^e)$ increases in n^e if the network effect is positive: the good is more valuable when the expected sales n^e are higher.

Model of fulfilled expectations

- As an example, we'll use:

$$v(n; n^e) = (1 - n)n^e$$

- n and n^e are normalized so that they represent market coverage, ranging from 0 to 1, rather than absolute quantities.
- Consumers that are indexed by low values of n value the subscription highly, whereas consumers that are indexed by n close to 1 place a low valuation on this service.
- This formulation was used in the very first paper to formalize network economics in the context of telecommunications subscriptions (Rohlfs, 1974).

Model of fulfilled expectations

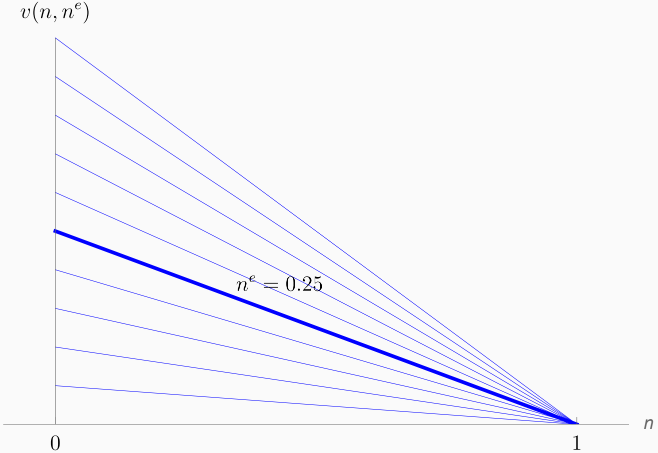


Figure. Value as a function of n when n^e is fixed to different levels, e.g. if $n^e = 0.25$ then $v(n; 0.25) = 0.25(1 - n)$.

Model of fulfilled expectations

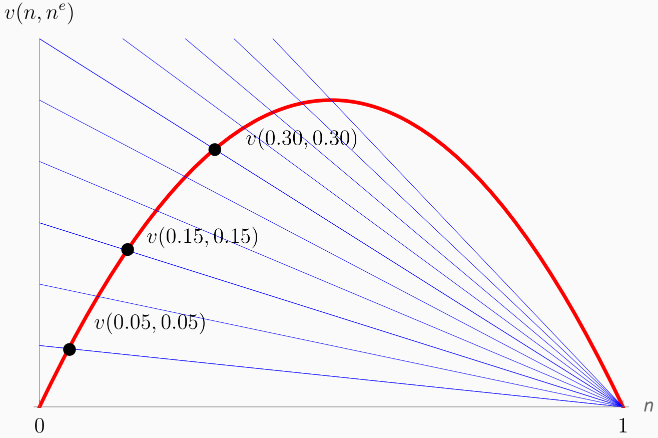


Figure. Three examples where n^e is fixed to 0.05, 0.15, 0.30 and the value is plotted as a function of n. The equilibrium points are at $n = n^e$.

Model of fulfilled expectations and prices

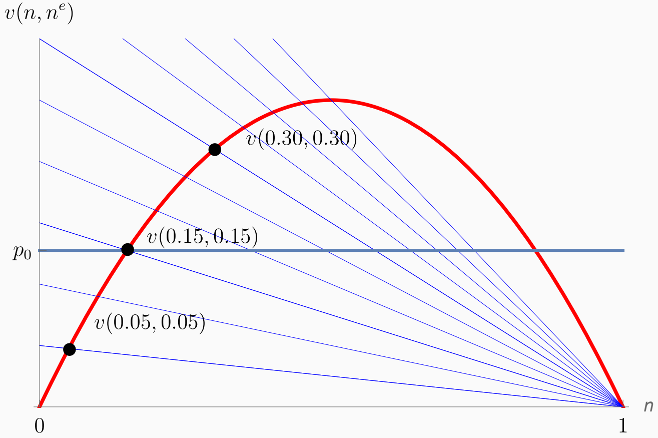


Figure. If price is set at $p_0 = (1 - 0.15) * 0.15$, then the marginal subscriber in equilibrium has a value of p_0.

Demand in network markets

The fulfilled expectations demand is increasing for small n if one of three conditions hold:

(i) The utility of every consumer in a network of zero size is zero.
  - E.g. Telecommunications, Facebook.

(ii) There are immediate and large external benefits to network expansion for very small networks.
  - E.g. Basically any WhatsApp group.

(iii) Many of high-willingness-to-pay consumers who are just indifferent on joining a network of approximately zero size.
  - E.g. Software, such as R, Python or Julia.

As a result, some portions of the curve demand can slope upwards (compare with the law of demand for traditional goods).

Source: Economides and Himmelberg, 1995.

Market clearing quantities and prices

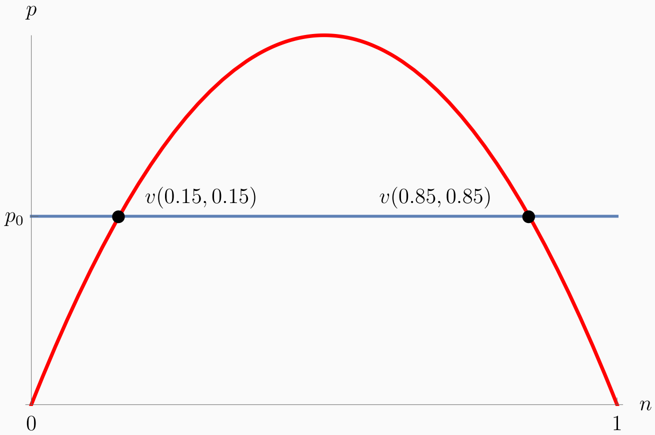


Figure. But also $(1-0.85)*0.85$ is an equilibrium at the same price p_0.

Multiplicity of equilibria

- Above, the first equilibrium $(0.15, 0.15)$ is unstable:
  - A small increase in n increases the consumer surplus for all old users of the network.
  - At the same time, the producer surplus increases.
- The second equilibrium $(0.85, 0.85)$ is stable:
  - Back to the “normal” downward sloping part of the demand curve.
- Multiple equilibria are a result of the coordination problem.
  - Everyone would be better off at $(0.85, 0.85)$.
  - But need to coordinate the expectations to reach that point.
  - Network operators may facilitate coordination by e.g creating expectations and pricing differently as the network increases.

Efficiency

- In perfect competition, prices will equal marginal cost.
- But if there are network effects, then marginal cost pricing is no longer efficient.
- When making a decision to join the network, individuals count only their own benefits.
- With a positive network *externality*, the marginal benefit to the society is greater than the marginal benefit to any one individual.
- (Note that the network externality may also be negative, and then the reverse is true. Road congestion is an example.)

Efficiency

- Socially optimal size of the network is different from the size resulting from competition.
- This is an argument for government subsidies:
  - E.g. railroad networks receive subsidies in many countries.
  - But the best form of the subsidy can be problematic.
- Monopoly does not necessarily choose optimal size:
  - Incentive of the monopolist to restrict output can outweigh its incentive to increase consumer demand by influencing expectations about network size.
  - If the network firm is allowed internalize the external benefits (i.e. take the money), then the service level can be closer to socially optimal than with strict enforcement of competition.

Impact of costs

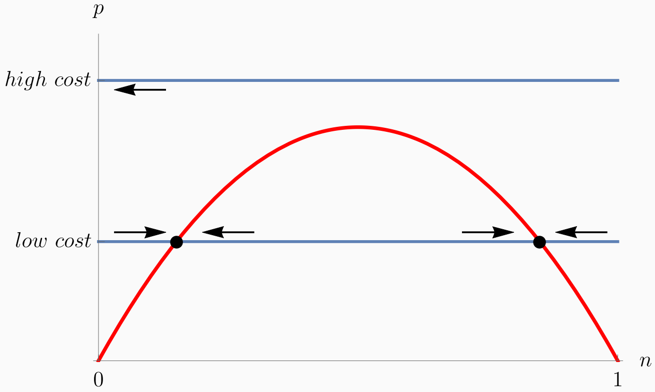
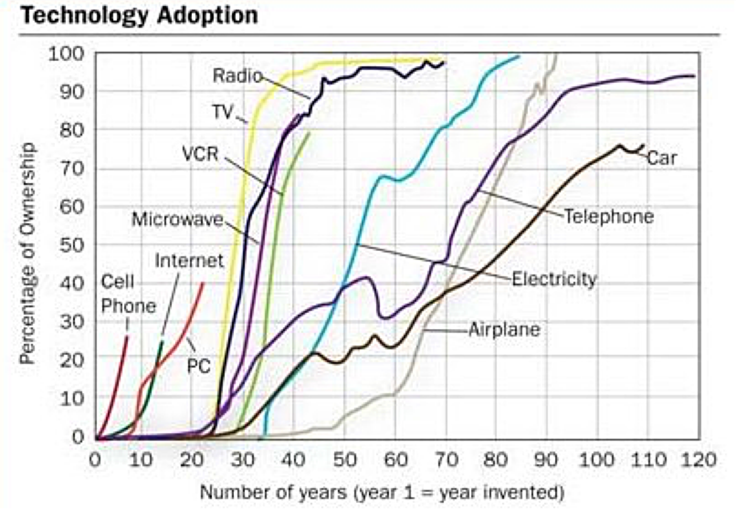


Figure. In competitive markets, the price will be set on the basis of cost. When costs are high, equilibrium is at zero. If costs come down, other equilibria become possible.

Network adoption

- The existence of an upward slopping part of the demand curve and the multiplicity of equilibria even under perfect competition also allows for a network to start with a small size and then expand significantly.
- It is possible that the industry starts at the left equilibrium as expectations are originally low or/and costs are high, and later on advances quickly to the right equilibrium.

Adoption – Examples



Source: Forbes Magazine.

Learnings today

- Network effects are generated by increasing the adoption rate (popularity) of a good or a service.
- Network effects affect demand and the market equilibria: demand curve can be upward sloping and there can be multiple equilibria.
- Social efficiency is harder to achieve, because competition does not reward for the externalities.

Readings for this lecture

- CORE (2018) "The Economy", Unit 21.4.
- Katz, M. and C. Shapiro (1994) "Systems Competition and Network Effects", The Journal of Economic Perspectives, Vol. 8, No. 2
    - Most of this should be accessible on the basis of the lecture.
    - Although some of the examples are outdated and we will update to the theory of platforms in the next lecture, this is still a comprehensive read.

Exercises for Lecture 8

1. Network effects can result in a “winner-take-all” competition.
   (a) What is the economic mechanism that supports “winner-take-all” argument?
   (b) Why do you think the argument can fail?

   For (a) there would be a correct answer, for (b) its more your best guess at this stage. Neither of the answers needs to be long.

2. Choose one successful social media network (e.g. Facebook, Instagram, LinkedIn, Snapchat, Twitter, WhatsApp). Describe, again, briefly:
   (a) How did the company manage to increase its user base early on?
   (b) How does the company manage expectations on its future size? I.e. what does it tell to the public? Quickly check e.g. their ads, websites, or annual reports.