Supply-side economies of scale *versus* demand-side economies of scale (network externalities, network effects)

- **Supply-side economies of scale** (or simply economies of scale) are a function of production size (value of turnover), whereas **demand-side economies of scale** (or simply network effects) are a function of number of users.

- Economies of scale (≠diseconomies of scale) are cost advantages due to business expansion, when output rises than the average cost per unit of production falls.

- In the payments market when the number of transactions with an electronic payment instrument soars, then fixed costs are spread over more transactions. Because variable costs are very low, then - as a result - considerable cost savings arise.
Network externalities (network effects)

✓ Special form of externalities.
✓ Network externalities are positive consumption externalities that occur (strongest) for particular consumption (network) goods.
✓ Network goods:

"products for which the utility that a user derives from consumption of the good increases with the number of other agents consuming the same good" (or a compatible good) (Van Hove 1999).

=> goods are components of the same (virtual) 'network'.
✓ In order to enjoy the network effect one must join the network.

Two types of network effects

✓ Direct, also called demand network effects:
  – The more users of a product, the bigger direct value of this product to all users,
  – Examples: telephones, fax machines, pagers, e-mails, social networks (Facebook, LinkedIn, MySpace, Grono, Nasza Klasa, GoldenLine, etc.).
✓ Indirect, also called supply network effects:
  – Increased usage of the product has no effect on its direct utility for users, however spawns the production of increasingly valuable complementary goods, and this results in an increase in the value of the original product for users.
  – Examples:
    ✓ Hardware/software: more PCs (or Macs) sold => more compatible software available => utility of hardware ↑;
    ✓ More DVD players acquired => more DVD with films (and other content) sold => utility of DVD players ↑;
    ✓ More Sony PlayStation consoles sold => more games invented and traded => utility of PS consoles ↑.
How to measure the value of direct network effects in a network?

- Metcalfe: \( n^2 \) or \( n(n-1)/2 \)
- Odlyzko, Tilly: \( n \log(n) \)
- Reed: \( 2^n - n - 1 \)

If we assume that the number of links (\( y \)) can be transposed on money value (€), then using for instance Metcalfe’s formula for \( n=10 \) \( y=45€ \) and for \( n=100 \) \( y=4950€ \).
Network effects *versus* network externalities

- Liebowitz and Margolis (1995) made a distinction between network effects and network externalities. If network effects are internalised by participants they are no longer network externalities.
- Fall in the price of a network good caused by entry of more users is a pecuniary externality which is in fact a network effect, not a network externality.
- Most of specialists does not make this distinction.

Demand-side economies of scale

- Varian (2003):
  
  „I like to use the terminology ‘demand side economies of scale’ since it forms a nice parallel with the classic supply side economies of scale discussed in the previous section. With supply side economies, average cost decreases with scale, while with demand side economies of scale, average revenue (demand) increases with scale“.
Payment cards (debit and credit) analogy to hardware/software

- Payment cards exhibit only indirect network effects, because typically they do not allow to initiate peer-to-peer (consumer-to-consumer) payments:
  - entry of extra cardholder $\rightarrow$ increase of utility of existing cardholders,
  - entry of extra cardholder $\Rightarrow$ more merchants accept the cards $\Rightarrow$ increase of utility of cardholders (old and new)
- i.o.w., card = hardware and merchant acceptance = software

We can classify payment instruments according to whether they exhibit both network effects or only indirect network effects...

| Typical payment instruments and characterising them kinds of network effects |
|---|---|---|
| Cash | Direct network effects | Indirect network effects |
| Cheque | + | + |
| Debit, credit card* | + | + |
| Credit transfer | + | + |
| Direct debit | + | |
| Hardware money** | + | |
| Software money | + | + |

*MoneySend service of MasterCard and Visa. Direct service of Visa facilitate C2C (P2P) payments, but they are not commonly used because of minor number of banks participating in these services.

**The Mondex scheme has a C2C (P2P) functionality, however most often e-purses schemes are deprived of this function.

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E-money’s legal definition (EU)

- Electronic money means electronically, including magnetically, stored monetary value as represented by a claim on the issuer which is issued on receipt of funds for the purpose of making payment transactions as defined in point 5 of Article 4 of Directive 2007/64/EC, and which is accepted by a natural or legal person other than the electronic money issuer (article 2 point 2).

- Issuance and redeemability (article 11):
  - Member States shall ensure that electronic money issuers issue electronic money at par value on the receipt of funds.
  - Member States shall ensure that, upon request by the electronic money holder, electronic money issuers redeem, at any moment and at par value, the monetary value of the electronic money held.


- Monetary value, as represented by a claim on the issuer, which is:
  - stored on an electronic device;
  - issued upon receipt of funds in an amount not less in value than the monetary value issued;
  - accepted as a means of payment by undertakings other than the issuer.

  (Based on Directive 2000/46/EC of the European Parliament and of the Council of 18 September 2000 on the taking up, pursuit of and prudential supervision of the business of electronic money institutions.)

- 3 important features:
  - Stored value, off-line settlement;
  - Pre-paid instrument (pay before);
  - Multi-purpose (not single purpose like phone cards).

E-money in practice

- E-money – according to a technological division criterion can be divided into:
  - Hardware based (stored on electronic purses, pre-paid cards equipped with a chip),
  - Software based (stored on computer discs). Software money is i.o.w. network money (there used to be a difference in the meaning between software and network money but there is rather not any longer).
  - The carrier of information can be any (mobile phones, watches, pendants), provided it has a kind of microprocessor ... Baja Beach Club in Spain (electronic wallets and club ID under the skin VeriChip RFID tags).

- Most popular e-money (closer or less close) synonyms are: digital cash, cyber money, computer money, electronic cash etc.
Problem of a critical mass (a chicken-and-egg problem, problem of an installed based)

✓ Hardware money: merchants will not invest in terminals without a sufficient number of potential users, while the general public will not use electronic purses unless there is sufficient acceptance.

✓ “For many network goods, the critical mass is of significant size, and therefore for these goods small market coverage will never be observed – either their market does not exist or it has significant coverage.” (Economides, Himmelberg 1995). It relates to hardware money schemes.

Network effects models

✓ Assumption: Consumers are rational and surplus-maximising.

✓ Utility of a network good

\[ a + b(n) \]

where

- \( a \) = stand-alone benefit (autarky, inherent value)
- \( b(n) \) = network benefit (increasing function of network size; \( b(0) = 0 \))

! decision before the actual network size is known

=> consumers will have to form **expectations**: \( a + b(n^e) \)

✓ Cost of a network good = price \( p \)

✓ Decision

\[ a + b(n^e) - p \geq 0 \]?

! ‘pure’ network goods: \( b(n^e) - p \geq 0 \)?

Payment systems have no autarky value, are pure networks (hence payment instruments are perfect network goods).
Expectations about network size (installed base)

✓ For a take-off of a product in isolation it is needed that either

\[ a + b(n^e) - p \geq 0 \] or
\[ b(n^e) - p \geq 0 \]

=> Critical mass is needed, what poses chicken-and-egg problem

- expectations low => not enough consumers to make product sufficiently useful => n = 0

=> Once the point of a critical mass is achieved, the bandwagon starts rolling.

- the process is self-reinforcing => the more card users => the more merchants accepting cards => the greater utility of the system => the more cards users => the more merchants accepting cards (bandwagon rolls) (and so on until saturation comes into being – congestion problems).

Competing networks

\[ a_1 + b(n^e)_1 - p_1 > a_2 + b(n^e)_2 - p_2 \]
\[ b(n^e)_1 - p_1 > b(n^e)_2 - p_2 \]

✓ Consumers choose a network with a larger surplus.


✓ What counts in shaping expectations are: brand strength, publicity, inherent features of a network product.

✓ Can networks exist concurrently?

- Sometimes yes, sometimes no.

- Under certain circumstances, consumers have natural preference for one or other technology (network).

=> Hardware money systems are prone to ‘tipping’ & ‘lock-in’ = 0/1-market
Tipping and lock-in

- Model of Arthur (1989) on diffusion of technological standards:
  - Two competing technologies A and B; utility depends upon the number of previous adopters.
  - Arthur shows that if there are such increasing returns to adoption, the market is inherently unstable: "the two technologies cannot coexist indefinitely: one must exclude the other".
  - At certain point the competitive balance will tilt in favour of one of the two. This phenomenon is called tipping and creates a lock-in.
  - Also: this process is path-dependent; i.e. the outcome can depend on small chance events => importance of an early lead.
  - If there are two competing e-purses systems in a small area it is probable that there is room only for one of them. Finally one of them dominates the other, i.e. tips in. The other goes in a rapid decline. The first one becomes prevalent, captures most users and locks in. This creates significant barriers for new systems to enter the market, even if they are of a superior quality.

Chicken-and-egg deadlock

- „When network effects are present, there are normally multiple equilibria. If no one adopts a network good, then it has no value, so no one wants it. If there are enough adopters, then the good becomes valuable, so more adopt it —making it even more valuable. Hence network effects give rise to positive feedback” (Varian 2003).

- The critical mass concept:
  "an equilibrium market for the good does not exist unless the installed base is greater than a minimum level"
The fulfilled expectations demand curve
(static concept, homogenous in expectations and rational consumers, no autarky value, price is given – compare Economides and Himmelberg 1995, Katz and Shapiro 1985)

- For normal goods – demand slopes downward,
- For network goods – the willingness to pay increases with the numbers expected to be sold.
- Therefore, the fulfilled expectations demand curve has a U-inverted shape.
- $n^0$ is a point of a critical mass.

The fulfilled expectations demand curves

Figure 2. The fulfilled expectations demand curve with strong (a) and weak (b) network externalities. Source: based on Economides and Himmelberg [10, figure 2, p. 5].

A critical mass point $n^0$, $a$ is a level of a stand-alone benefit
No critical mass point
Supply and demand
(assumption: supply is perfectly elastic (Varian 2003))

- D humped-shaped fulfilled expectations demand curve
- first WTP increases due to NE, "eventually, the demand curve starts to decline due to the usual effects of selling to consumers with progressively lower willingness to pay"
- D assumption: no stand-alone value
- S perfectly elastic supply curve
- E two extreme equilibria are stable, middle is unstable = critical mass

Failures of hardware and network money
(*inter alia* due to the chicken-and-egg problem)

- ✓ Pioneer hardware money systems closed: Avant (Finland), Danmønt (Denmark), Multibanco (Spain).
- ✓ Many software money systems couldn’t reach the critical mass and eventually succumbed to competition (from PayPal predominantly): MoneyZap (launched by Western Union) c2it (introduced by Citibank and partnered by AOL and Microsoft), BidPay (again supported by Western Union), Yahoo! Pay Direct.
PayPal system success factors in overcoming the critical mass problem

- Software money system compatible with an existing banking infrastructure (linked to national interbank and card clearing systems) exhibiting both direct and indirect networks.
- Exploitation of a market gap (the lack of a multinational quick and efficient clearing centre for retail transactions).
- First mover advantage on the market of software money. Initial concentration on a segment of internet auctions (eBay), then expansion on a segment of e-shops.
- Adequate price strategy: low transaction fees (initially exemption from fees), no charges for opening, maintenance and uploading funds to the account, taking advantage of different price elasticity for payment services of two distinct groups of the demand-side of the market (buyers and sellers).
- Continuous development and diversification of products (new options - mobile payments, postponed payments - possibility to take out credit).
- Support of a big and strong institution (eBay).

E-purses from Hong Kong and Singapore – success determinants

Small and densely populated countries with communities open to innovations

Octopus Card (HK) and EZ-Link (SG)
Obligatory solutions for the territories’ mass transit systems

CashCard (SG)
Launched and supported by NETS (payment operator which is a proprietary of Singapore banks)
Hardware *versus* software money in the context of a chicken-end-egg deadlock

- For hardware money it is harder than for software money to cope with the critical mass problem, since it:
  - Exhibits only indirect network effects (therefore has lower utility for its users).
  - Requires setting up an additional costly infrastructure and economies of scale come later into being.
  - Does not allow to make internet payments, unless with a supplementary peripheral devise.

Summary

- New payment instruments like hardware money systems are subject to economies of scale and networks. Unless they do not exceed a certain threshold in terms of number of users (critical mass point) they disappear from the market. Only after significantly expanding in size such new payment schemes can give rise to cost reductions (economy of scale) and high revenues for issuers.
- Overcoming the chicken-and-egg problem is a hard task, but can be accomplished (compare PayPal, Octopus Card, EZ-Link, CashCard).
- Path-dependence, early lead, tipping and lock-in, fulfilled expectations demand curve, switching costs are key words that should be borne in mind. Network and scale effects, if properly recognised and exploited, can give a firm a serious advantage over competition.
Thank you for your attention

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