

# NETWORK ECONOMICS

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2017



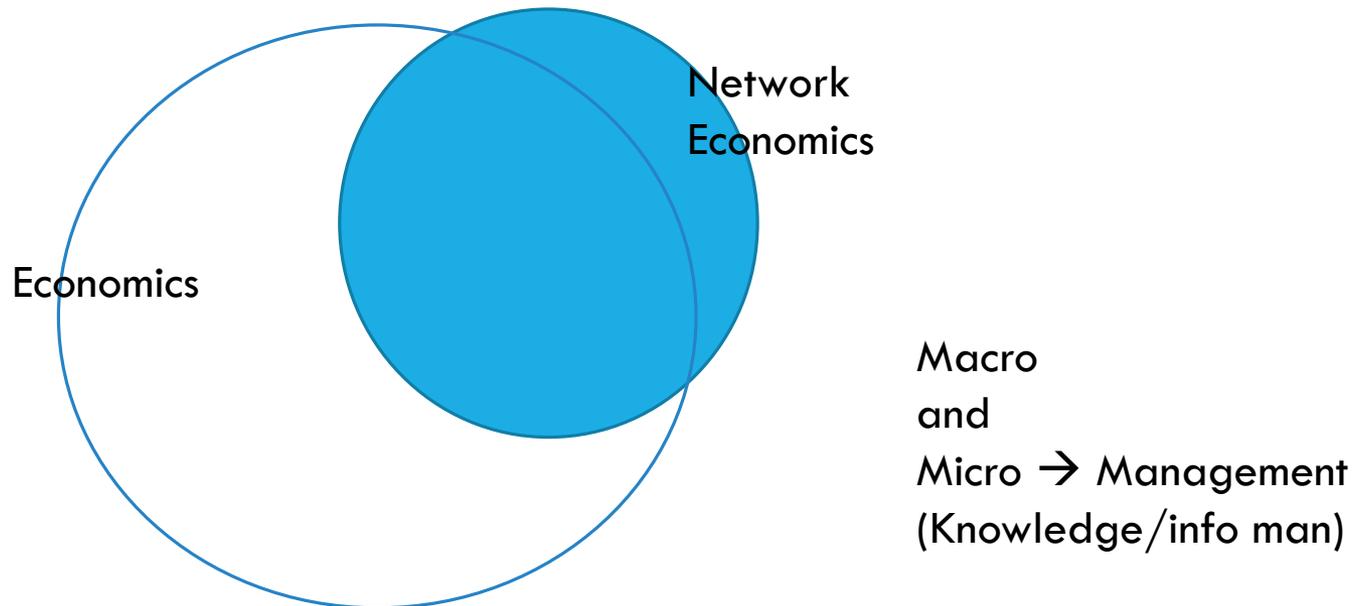
Why does the graphic interface of all operating systems, word processors look so similar?

Why don't we have keyboards that are much more suited to the characteristics of our native language?

Why can our computer play all the purchased CDs?

Why is Wikipedia for free if you had to pay a good 2-5 months wage for an encyclopaedia a few decades ago?

# ECONOMICS AND NETWORK ECONOMICS



Network economics discusses the special economic consequences of agents operating within the special circumstances of networks

# KNOWLEDGE & INFORMATION

‘We are drowning in information, but starved for knowledge’ - John Naisbitt

Knowledge-based economy: a more advanced type of economic structure

- its primary resource is renewable,
- and the creation of it is environment friendly

Tacit and explicit knowledge (Polanyi)

- Explicit: factual knowledge and knowledge of rules and regulations
- Tacit: tool that helps us in acquiring and creating new knowledge - like intuition, logic, associative skills, experience, traditions or apprehension

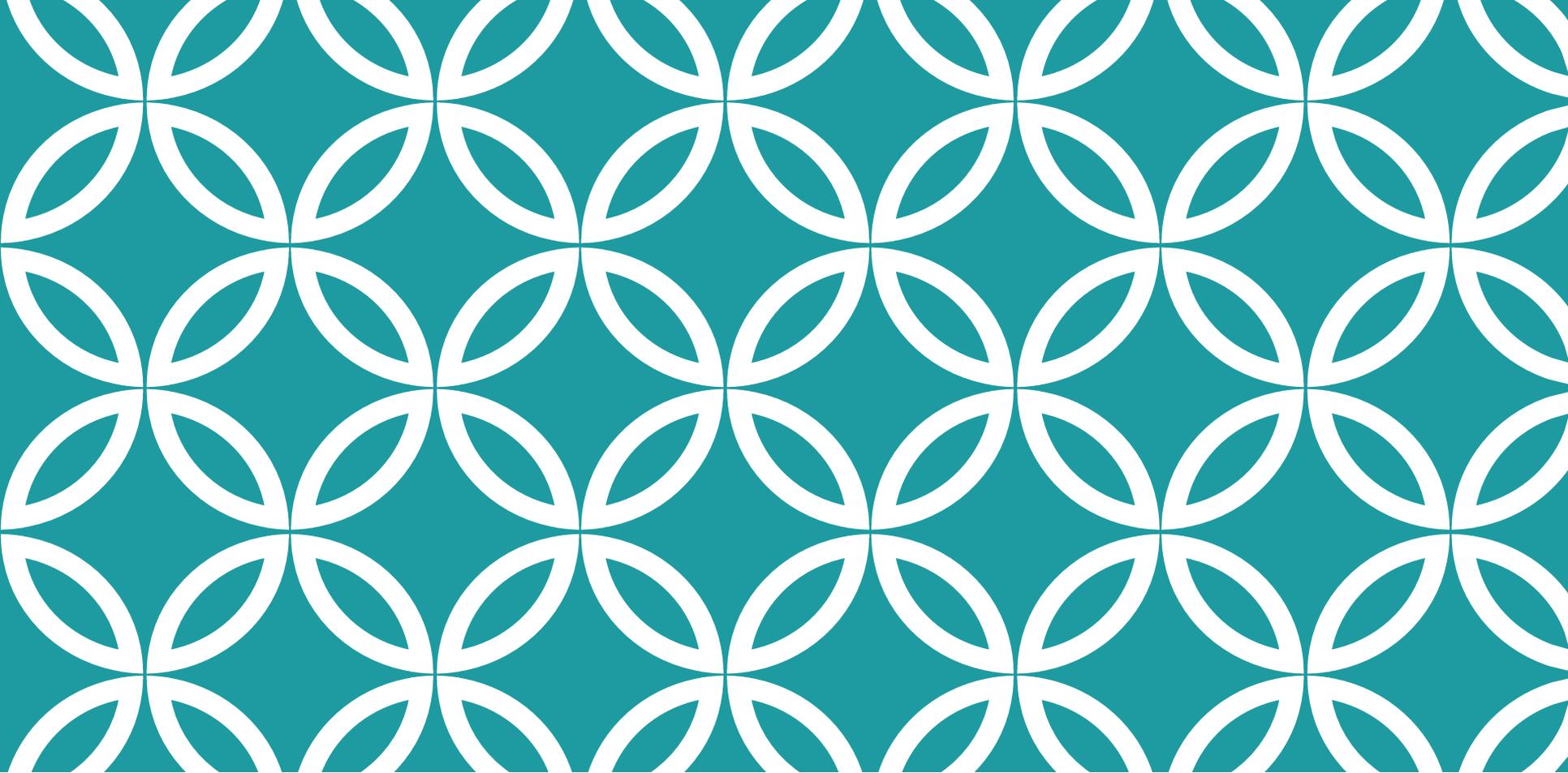
# INFORMATION TECHNOLOGY APPROACH

Alter: data-information-knowledge

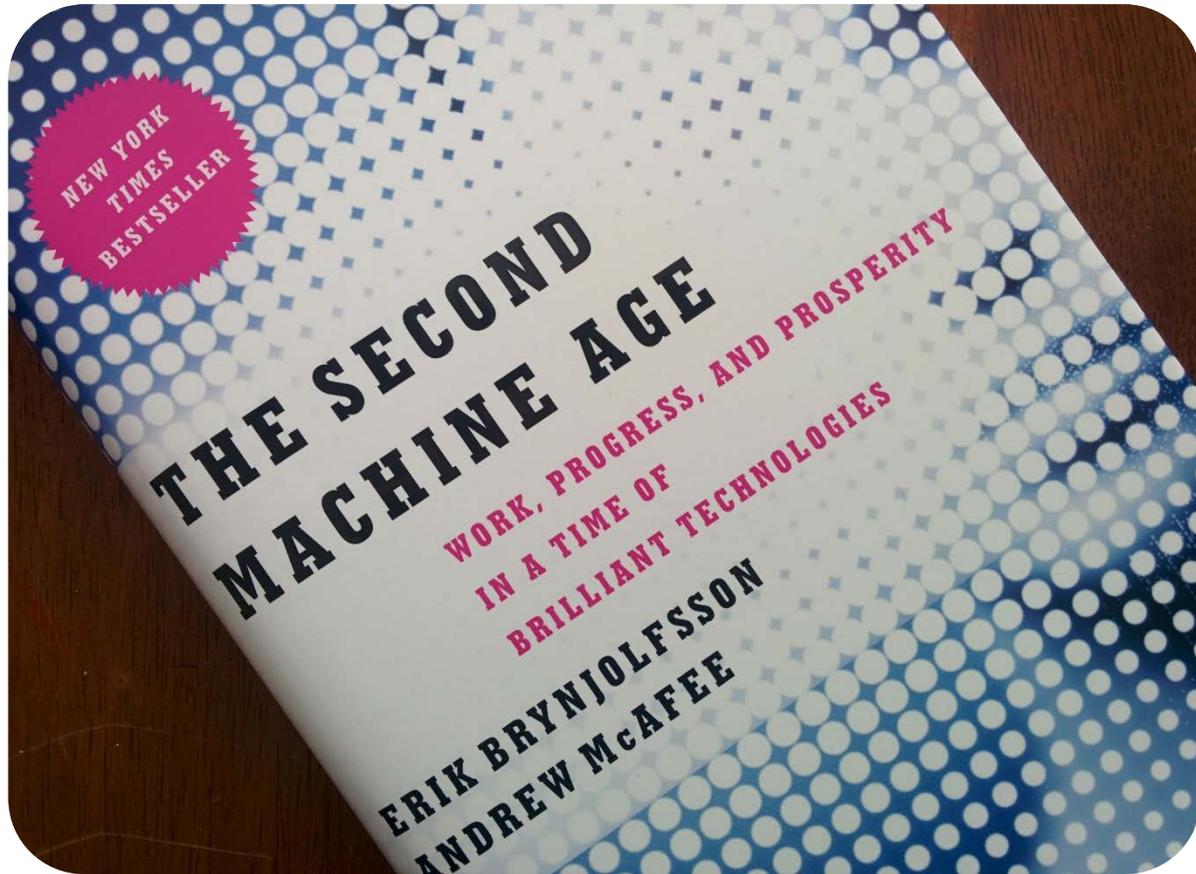
- data is a group of bits, characterising a segment of the described system.
- if a set data is structured and is ready for communication, we call it information
- knowledge: information is put into the necessary context, and so it can help in solving problems

Abundance vs. richness of information

Miller's law: an individual normally can retain or process only seven give or take two ( $7 \pm 2$ ) items (chunks) of information in their correct serial-order, in his or her short-term (15 to 30 seconds duration) of 'working' memory



# **CONTROVERSY: ROBOTS AND/OR MIGRANTS**



NEW YORK  
TIMES  
BESTSELLER

# THE SECOND MACHINE AGE

WORK, PROGRESS, AND PROSPERITY  
IN A TIME OF  
BRILLIANT TECHNOLOGIES

ERIK BRYNJOLFSSON  
ANDREW McAFEE



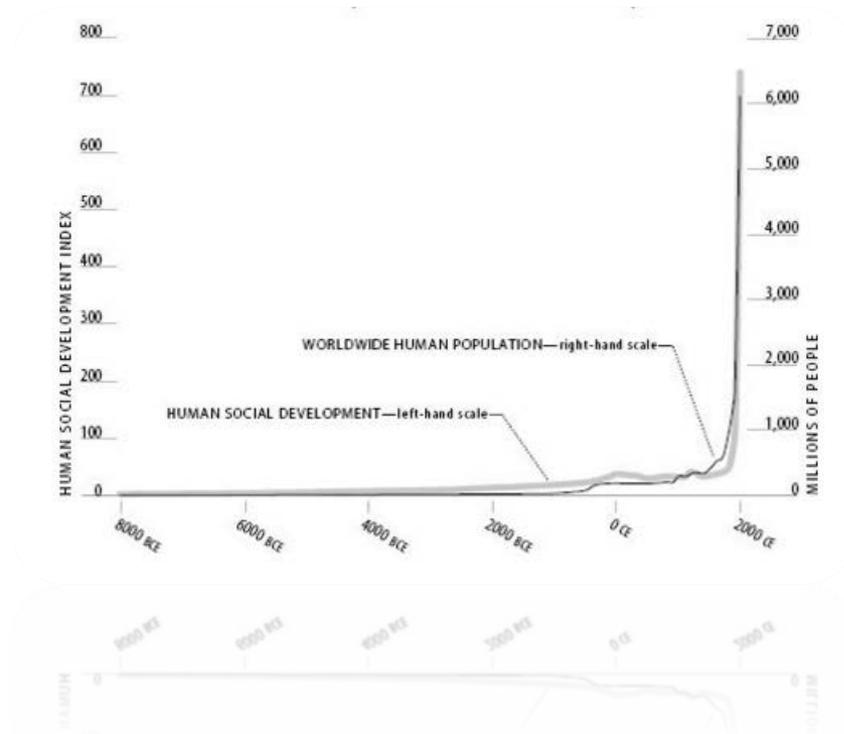
**"How did you go bankrupt?" Bill asked.  
"Two ways," Mike said. "Gradually and then suddenly."**

Ernest Hemingway: The Sun Also Rises

# BENDING THE CURVE — THE MOST SIGNIFICANT DEVELOPMENT IN HUMAN HISTORY?

## Ian Morris: Human Social Development Index

- A group's ability to master its physical and intellectual environment to get things done
  1. energy capture (per-person calories obtained from the environment for food, home and commerce, industry and agriculture, and transportation)
  2. organization (the size of the largest city)
  3. war-making capacity (number of troops, power and speed of weapons, logistical capabilities, and other similar factors)
  4. information technology (the sophistication of available tools for sharing and processing information, and the extent of their use)
- Each of them converted to 0-250, and then added up



The first machine age:  
machines carry out jobs that  
require manual power



The second machine age:  
machines carry out jobs that  
require mental power



# NATURE OF TECHNOLOGICAL CHANGE #1

Hard to predict

Frank Levy – Richard Murnane (2004): The New Division of Labor

- Pattern recognition or tasks that require a lot of tacit knowledge cannot be programmed
- 2014 – self-driving car by Google

Moravec's paradox (1988)

- „It is comparatively easy to make computers exhibit adult-level performance on intelligence tests or playing checkers, and difficult or impossible to give them the skills of a one-year-old when it comes to perception and mobility”
- high-level reasoning requires very little computation  $\leftrightarrow$  low-level sensorimotor skills require enormous computational resources
- ASIMO, DARPA Challenge, Boston Dynamics

# NATURE OF TECHNOLOGICAL CHANGE #2

1. Exponential nature
2. Digital nature – digitisation
3. Combinational nature

# 1. EXPONENTIALITY

Albert A. Bartlett: „The greatest shortcoming of the human race is our inability to understand the exponential function.”

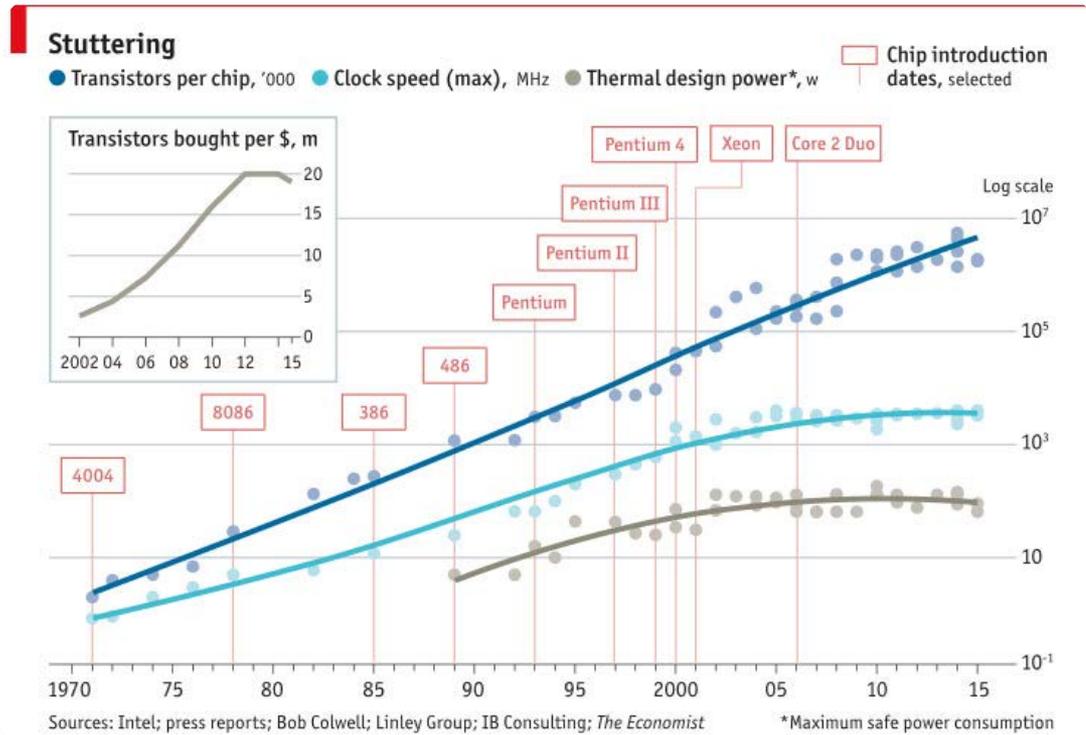
Second half of the chessboard: old story about the inventor of chess, and the reward

## Further examples

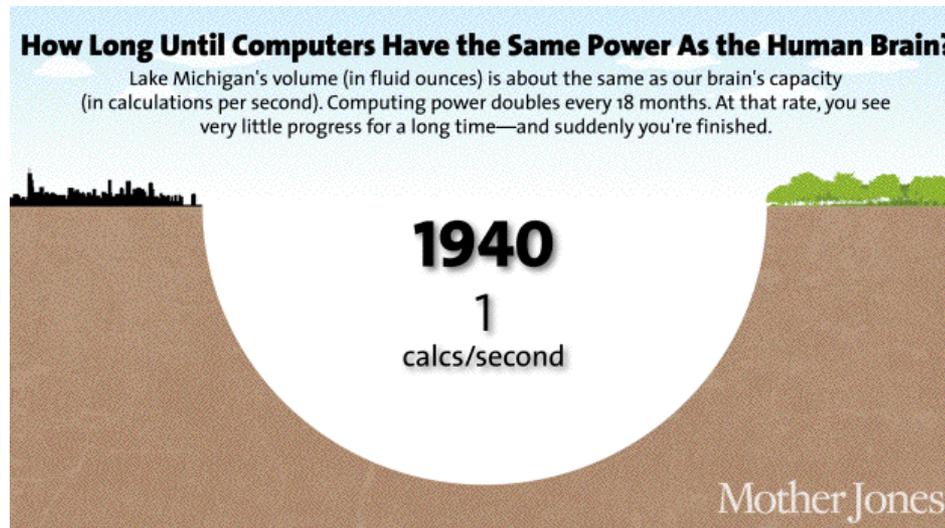
- Costs
  - 1996: ASCI Red supercomputer, costs \$55 million, size of a tennis court, 1 teraflop computing power, 800 kWh
  - 2006: Sony PlayStation 3, \$500, same computing power, 200Wh
- Since 1838 around 3,500 billion photos have been taken – 10% of those during the last year
- In 1997 IBM’s Deep Blue defeated Kasparov; a mobile phone now can run a chess software that is capable of ~2800 Elo-points; in 2016 Google’s AlphaGo defeats a top Go player

# MOORE'S LAW

Gordon Moore (1965): The complexity for minimum component costs has increased at a rate of roughly a factor of two per year



# EXPONENTIAL DEVELOPMENT



Source: <http://www.motherjones.com/media/2013/05/robots-artificial-intelligence-jobs-automation>

## 2. DIGITISATION

### Shapiro-Varian (1998): Information Rules

- Producing the first copy, producing further copies however, basically does not cost anything
- ~zero marginal cost (*Rifkin (2014): The Zero Marginal Cost Society*)
- Non-rivalrous

The more digital content is available the more positive externalities come from it (Google translate)

Running out of numbers: in 1991 it was agreed that the largest prefix will be yotta ( $10^{24}$ ) – the data transfer on the internet has reached this number

# 3. COMBINATIONAL NATURE

General purpose technologies: deep new ideas or techniques that have the potential for important impacts on many sectors of the economy (e.g. steam power)

Romer: Economic growth occurs whenever people take resources and rearrange them in ways that make them more valuable

ICT creates better solutions by recombining already existing ideas

- Waze: GPS satellites, digital map, smart phone

# BOUNTY VS. SPREAD



# BOUNTY

Milton Friedman: Most economic fallacies derive from the tendency to assume that there is a fixed pie, that one party can gain only at the expense of another

Can GDP measure the growth of bounty?

- Skype conversation – no change in GDP
- Sharing economy
- Digital goods for free

Estimating consumer surplus

- The more digital goods are available, the bigger the consumer surplus
- Varian: 1 search on google saves you 15 minutes

Less information asymmetry and lower transaction costs

- Online databases (prices)
- Reputation systems (eBay)

Billions can have access to content that was only available for the selected few before (e.g. MOOC systems)

# SPREAD

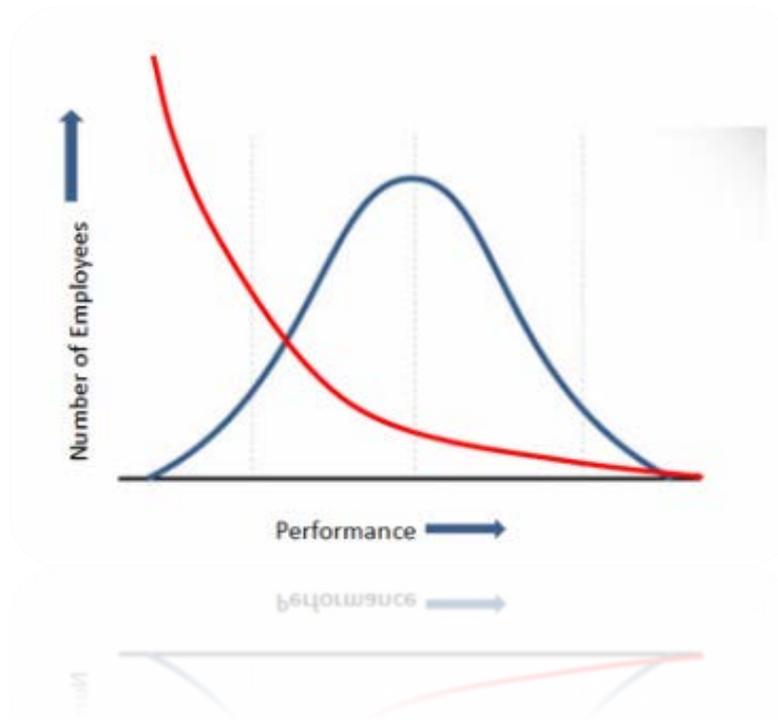
The pie increases, but the slices are not increasing equally – some can get a smaller slice from a bigger pie

Out of the 3,500 billion photos ever take 10% was made in 2013 – yet Kodak, that once employed 150,000 people went bankrupt in the very same year

## Normal and power law distribution

- Normal distribution: average income  $\sim$  median income
- Scale invariant (power law distribution): average income  $>$  median income
  - The average wage in the baseball league is \$3 million; the median wage is \$1 million
  - In a power law distribution of income the vast majority has a below average income
  - Disappearance of middle class

# GAUSSIAN VS. PARETIAN



# THE DECLINE OF MEDIAN INCOME

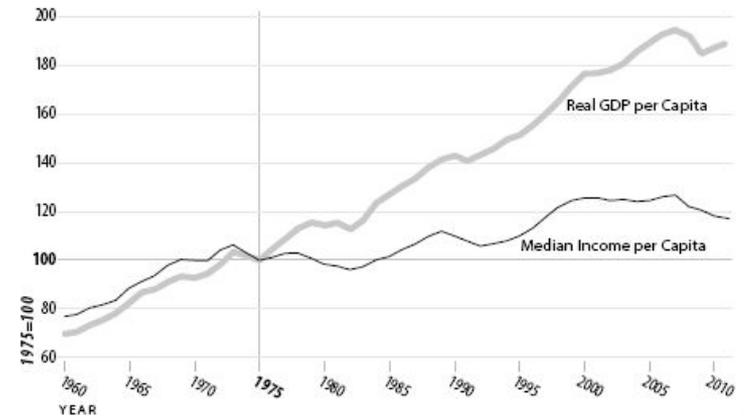
Productivity and wages take different paths

In the USA the median income was highest in 1999; in 2011 it was 10% lower than the '99 high

The wealth of Americans doubled a few times between 1983-2009, yet the wealth of 80% of them decreased

Lusardi, Schneider – Tufano (2011): could you get hold of \$2,000 in 30 days? 50% said it would be very difficult

FIGURE 9.1 Real GDP vs. Median Income per Capita



# BIASED GROWTH

The fact that the pie does not grow proportionately is caused by biased growth: certain resources are way more productive than others.

## 3 biases

1. Capital bias: robots and computers cost money
2. Skill bias
3. Talent bias

## 2. SKILL-BIASED TECHNICAL CHANGE

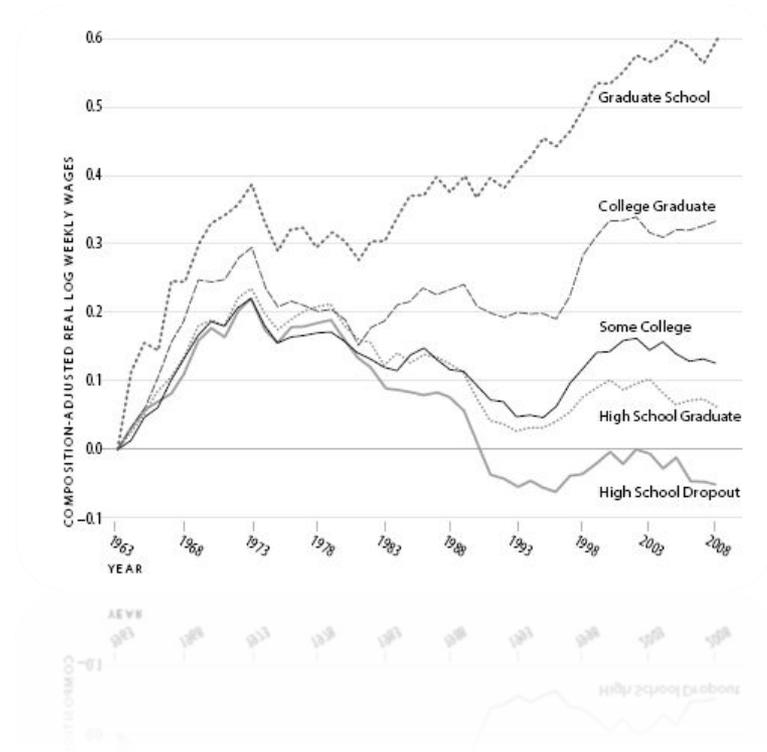
Wages for those with at least a tertiary degree increased while the number of people with university degrees increased as well

Acemoglu-Autor (2010): two dimensions in human labour

- Cognitive and manual tasks
- Routine and non-routine tasks
- Computers are better at routine tasks, be it manual (assembling) or cognitive (accounting)

Routine-cognitive: typical jobs for the middle class

- Between 1947-2000 labour's share from GDP decreased from 64.3% to 57.8%



# 3. TALENT-BIASED TECHNICAL CHANGE SUPERSTARS

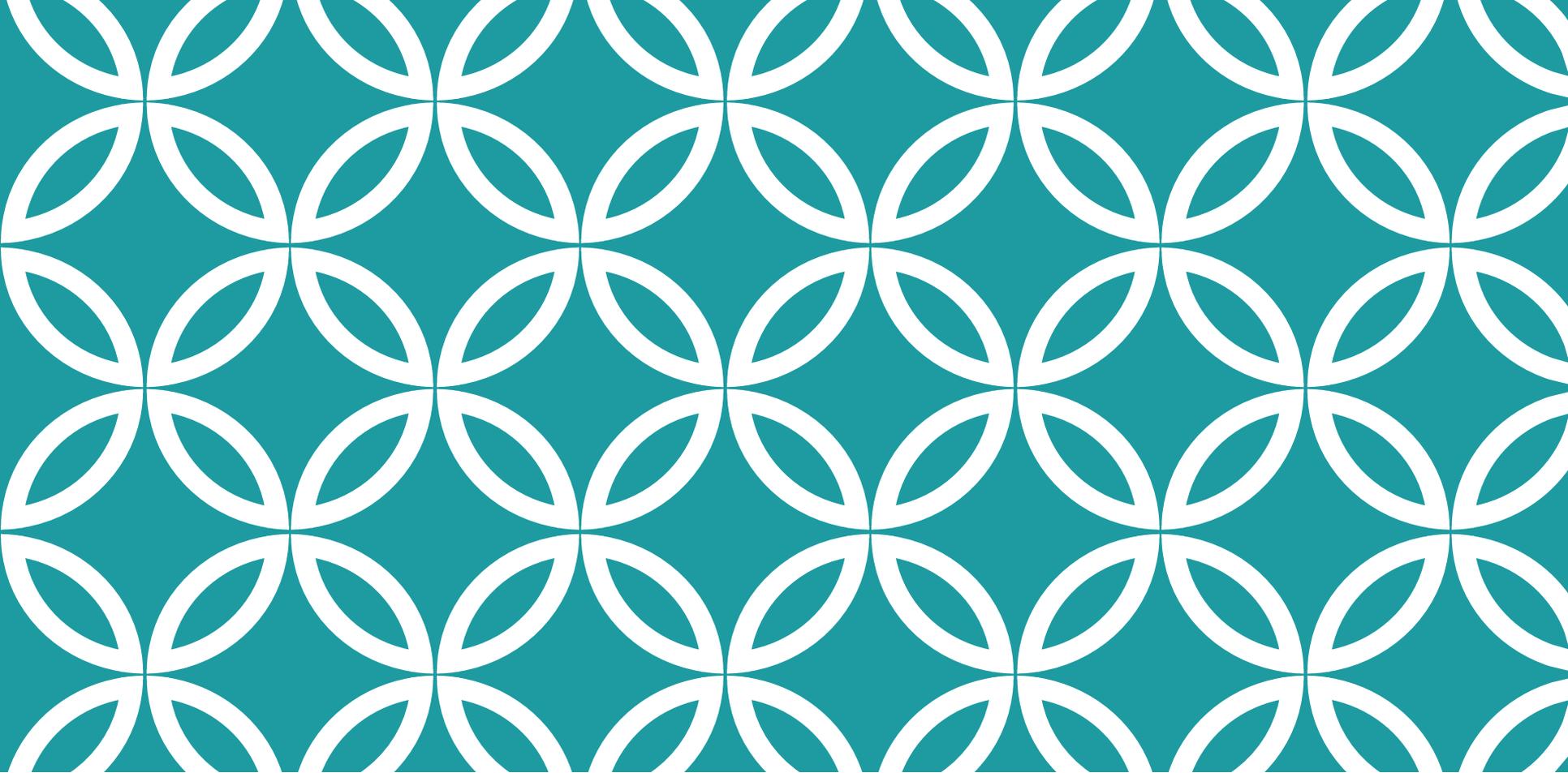
The big winners are those who possess the scarcest resources

## Absolute and relative performance

- Traditional markets: the best bricklayer lays 1,000 bricks per hour; the 10th best lays 900 → the difference in their wage would be 10%
- Winner takes all markets: the best online market site has 20 million products on offer; the 10th best has 10 million → nobody will use the 10th best, so the income of the latter is 0 (instead of being only half of the best one in a traditional market)

## J. K. Rowling is the first billionaire author – what makes her special or better?

- In most markets consumers prefer the better quality over the worse one, but because of some limitations only a few have access to the best quality
  - Capacity limitations
  - Difficult reach – transportation costs
  - Other transaction costs
- How can ICT break down these limitations?
  - Digitisation – can be produced at zero marginal cost
  - Global market (wherever there is internet, there is Amazon)
  - Network effect – demand side economies of scale (e.g. Waze)
- Institutional changes: globalisation, free trade, culture of mega wages



# WHAT'S BIGGER: BOUNTY OR SPREAD?

# STRONG BOUNTY ARGUMENT

There is no such thing as technological unemployment

- Although many have lost their jobs because of technology, over the long term demand for labour arose in other industries

Classical argument: technical progress → more efficient technology → lower costs → lower prices → increased demand → increasing output and more jobs

Further arguments:

- Many digital products are free of charge – it does not matter if the median wage declines
- Prices have been falling quickly – quality has been on the rise
- Smart phones offer zillions of apps and functions – increased quality of life

# WEAK BOUNTY

Keynes: One might choose to work less – and to consume less; the significance of leisure time

Arthur C. Clarke: “The goal of the future is full unemployment, so we can play.”

How low wages can go?

- If a machine can take the job, wages can go down near zero – not a living wage
- Below a certain wage unemployment is no longer voluntary

Racing with and not against the machines: e.g. freestyle chess

Comparative advantage of humans compared to machines:

- Ideation: thinking outside the box
- Large-scale pattern recognition: solution with a new approach
- Complex communication

# SCHOOL SYSTEM AND OUR COMPARATIVE ADVANTAGE

Sir William Curtis: 3R (1825) – Reading, wRiting, aRithmetic

Sugata Mitra: the British Empire created a global administrative machine that could be operated by educated people → they were produced by the education system

- The global economic system has long since changed, but the education system still keeps pumping out the same kind of people
- SOLE – Self-Organising Learning Environment

Hal Varian: seek to be an indispensable complement to something that's getting cheap and plentiful

# WHAT'S NEXT?

## SHORT TERM

Keep to the recommendations of economics textbooks

Focus on education

- Hanushek-Woessmann: strong relation between better education performance and economic growth
- Chetty, Friedman, Rockoff: if you replace the 5% worst teachers with average ones, the student's lifetime earnings increases by \$250,000
- Impact of technology on education is almost non-existent

Entrepreneurship

- Kane (2010): in the period of 1977-2005 startups had created 3 million jobs/year, other forms have destroyed 1m

Matching services

- Knack, TopCoder, HireArt, oDesk

Funding for basic research

Infrastructure and migration

Taxing:

- Pigouvian taxes, pay roll taxes, consumption taxes

# WHAT'S NEXT?

## LONG TERM

### Basic income

- Voltaire: Work saves a man from three great evils: boredom, vice, and need

### Friedman: Negative income tax

### Crowdsourcing

- Daren Brabham: an online, distributed problem-solving and production model
- Peer economy:
  - TaskRabbit – offering labour for others
  - Airbnb or Uber – offering assets for others

### Further ideas

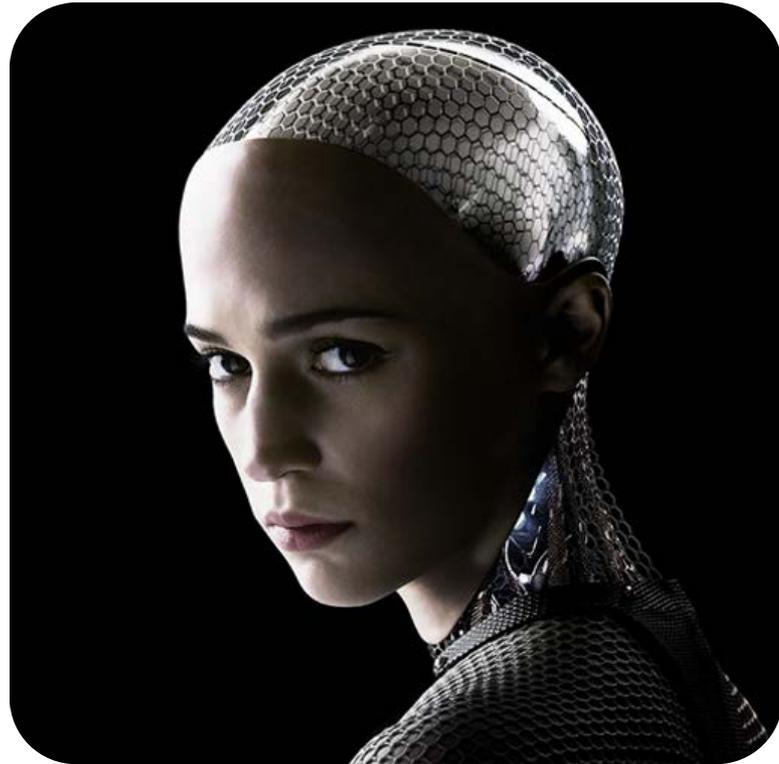
- J. Rifkin: Zero marginal cost society – cooperative commons
- National Mutual Fund – paying dividends to citizens
- Incentives for developing machines that supplement and not replace human labour
- „Socially beneficial activities”
- Special jobs only to be filled by humans
- „Made by humans” badges
- Workfare – public work

# HOW LONG BEFORE AI (HLMI) IS DEVELOPED?

	10% chance	50% chance	90% chance
Saloniki MI conference, 2012	2023	2048	2080
Oxford MI conference, 2012	2022	2040	2065
EETN survey, 2013	2020	2050	2093
TOP 100 authors survey, 2013	2024	2050	2070
Combined	2022	2040	2075

Source: Nick Bostrom – Superintelligence (2014), p46 (hun edition)

“TECHNOLOGY IS A GIFT OF GOD. AFTER THE GIFT OF LIFE IT IS PERHAPS THE GREATEST OF GOD’S GIFTS. IT IS THE MOTHER OF CIVILIZATIONS, OF ARTS AND OF SCIENCES.”—FREEMAN DYSON



# INSTITUTIONAL APPROACH

Does science and education have an affect on the economy?

Bernal (1939): was the first one to suggest that governments could use the scientific sector in order to achieve their social and economic goals

Innovation system (Freeman): firms, research institutes and other economic or scientific entities form a network that fundamentally determines the economic potential of a region

# BUSINESS KNOWLEDGE

Not all bodies of knowledge are relevant for the economy and businesses

Lundvall

- **Know what.** Know what basically is equal to information. It comprises of knowledge that is easily recorded and stored in forms of bits.
- **Know why.** Know why includes the knowledge of scientific rules.
- **Know how.** It comprises skills and experiences that help the solving of certain problems. Know how usually is acquired when doing things.
- **Know who.** Know who consists of information and experience about who knows things about certain problems.

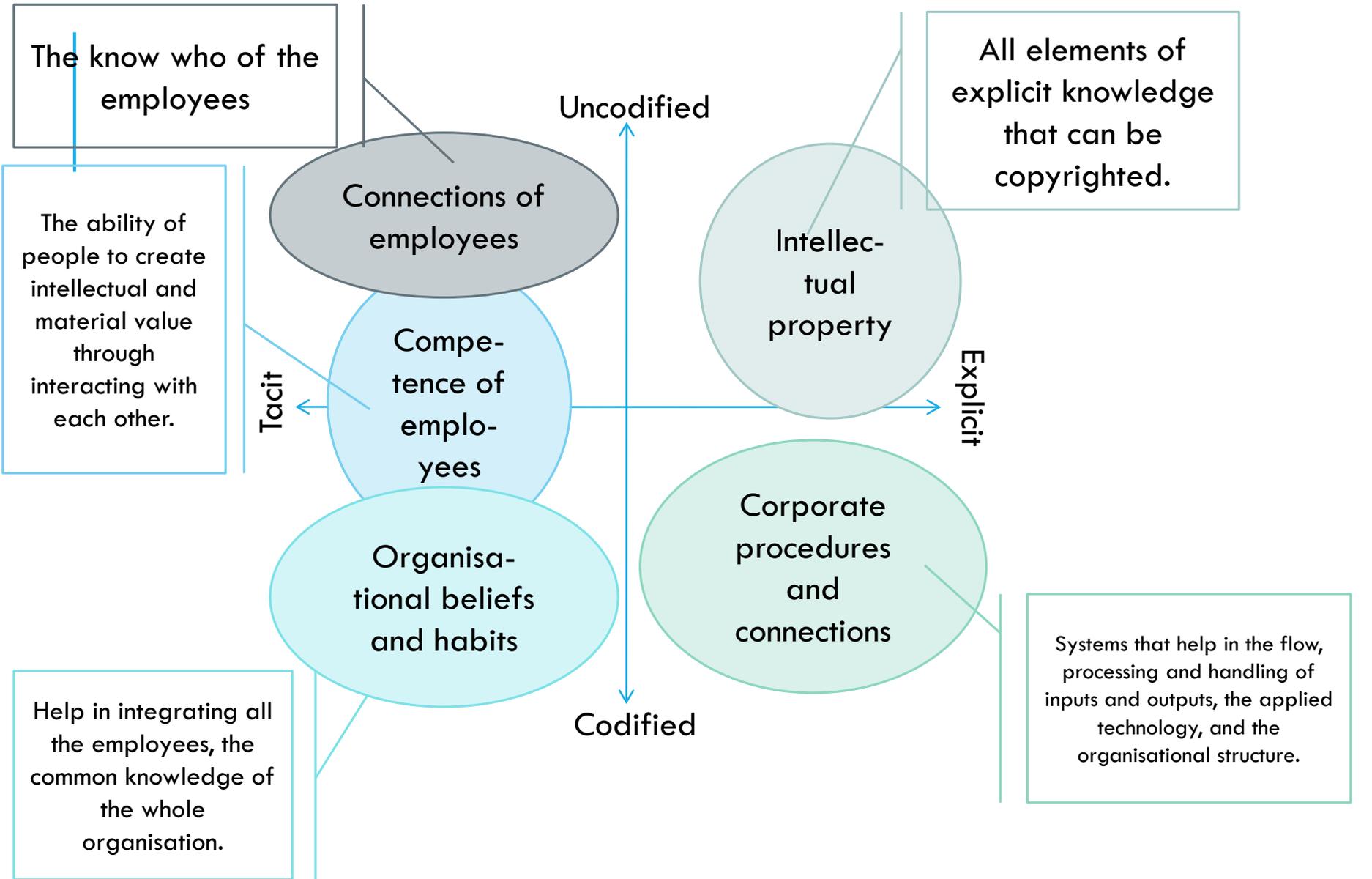
# BUSINESS KNOWLEDGE

The combination of action related skills and codified information that contribute to the effective combination of resources, and so to the profitable operation of the company

Availability: is it tacit or explicit

Specific nature: the rate at which the knowledge is linked to the organisation

- Codified and non-codified knowledge



# MANAGING KNOWLEDGE

Feature	Industrial paradigm, industrial point of view	knowledge paradigm, knowledge point of view
People	cost producers, resources	revenue producers
Powerbase of the manager	position taken in the organisational hierarchy	knowledge possessed
Power struggle	black collar versus managers	knowledge workers versus managers
Main task of the manager	controlling workers	supporting workers
Information	means of control	tool of communication, a resource
Production	black collar worker use physical inputs to produce physical outputs	knowledge workers transforming knowledge into intangible structures
Information flow	through the organisational hierarchy	through the networks of employees
Primary source of revenue	money	intellectual (knowledge, learning, R&D)
Bottlenecks during production	capital and human skills	time and knowledge
Result of production	hardware	software – intangible structures
Production process	machine-driven, structured	thought-driven, chaotic
Effect of size	economies of scale	economies of choice
Consumer relations	one-sided, through market relations	interactive, through personal networks
Knowledge	one asset from many	the focus point of business
Goal of learning	application of new tools	creation of new value
Shareholder value	determined by physical structures	determined by intellectual structures
Return during operation	decreasing returns	decreasing and increasing returns at the same time

# ECONOMIES OF CHOICE

Economies of scale: driving down average cost by increasing the volume of production

Economies of choice: creating many versions of the same solution – versioning or price discrimination

- Different versions – same solution but different packaging
- Too much choice...

# INCREASING RETURNS

Increasing vs. diminishing returns

Reproduction costs are minimal compared to the costs of creating explicit knowledge, so the more copies are sold, the lower the average cost will become

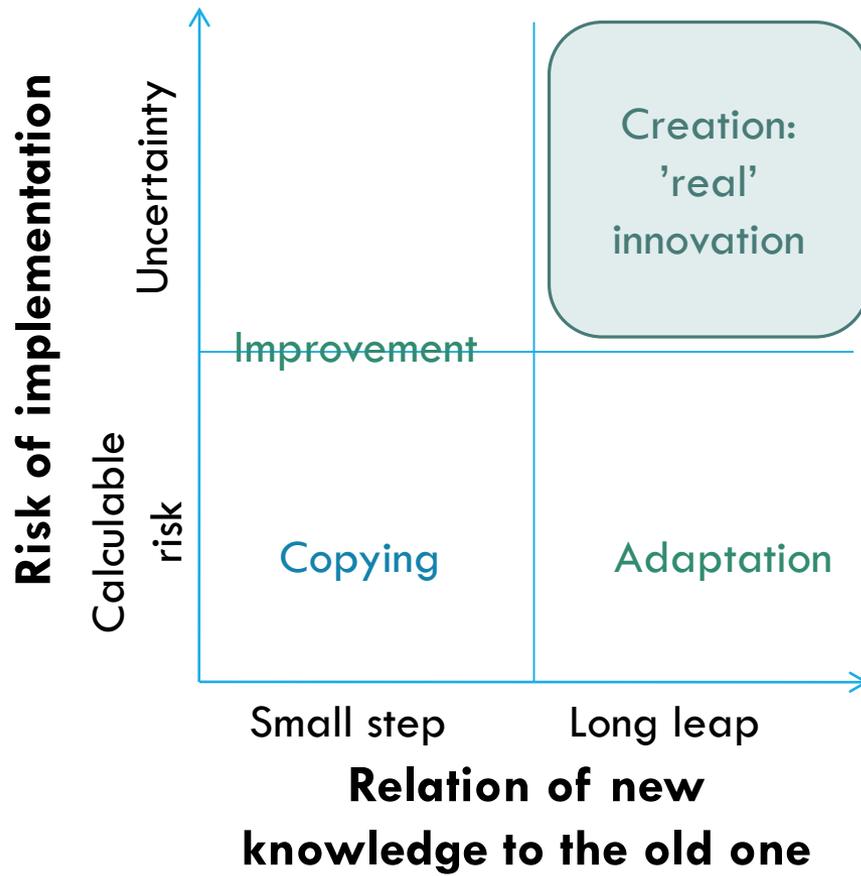
A basic characteristic of tacit knowledge is that it can be increased through the use of it - the fact that tacit knowledge may be accumulated through its application leads to increasing returns



# EXPLICIT KNOWLEDGE CREATION

The process of creating explicit business knowledge is called innovation

What is new?





# TACIT KNOWLEDGE CREATION

New tacit knowledge is created through explorative learning – i.e. learning through discovery

Very slow process, most difficult to do



# KNOWLEDGE DIFFUSION

Explicit knowledge: transfer

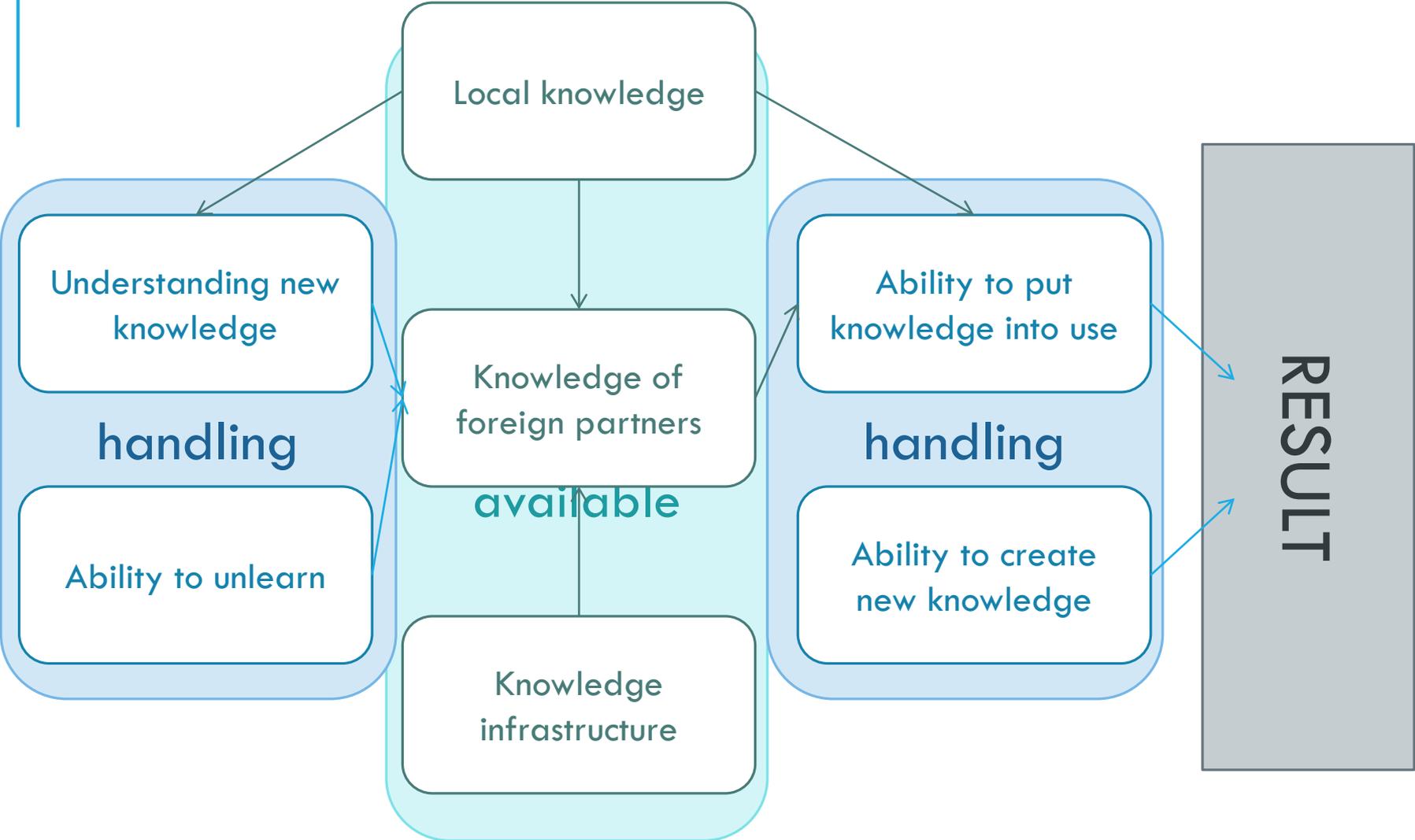
- Commercial and non-commercial transfer

Tacit knowledge: mimicking learning

Intra-organisational learning

Learning by doing

# MODEL OF LEARNING



# SOME OTHER KEY IDEAS

Experience good

Infrastructural nature

Asymmetric information

Sunk cost

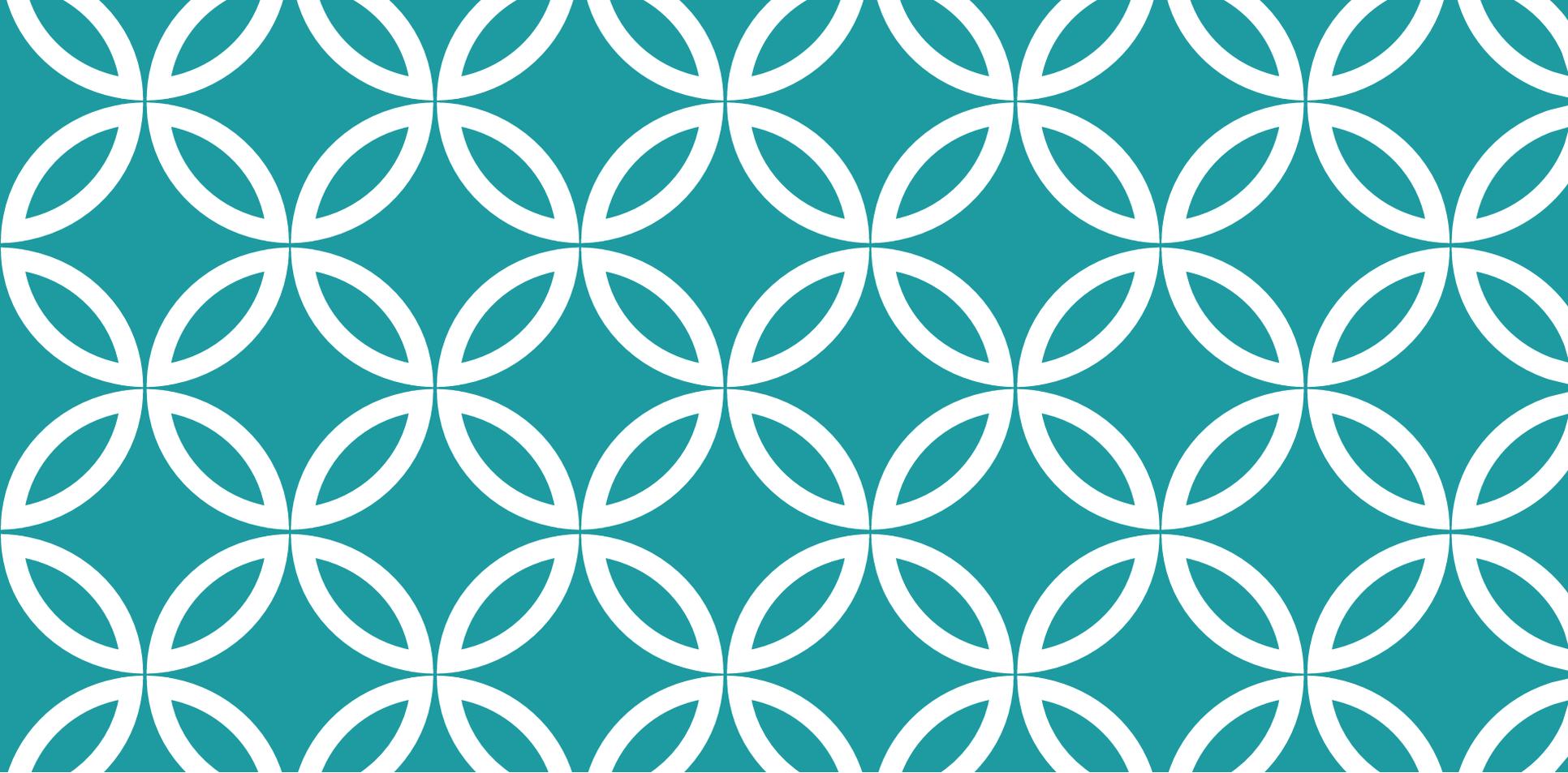
Marginal cost of zero

Knowledge-related costs

- Cognitive: sender and receiver side
- Time cost
- Moral cost

Consumers usually look for business knowledge that has low cognitive and time costs for the buyer, and has a high moral cost for the producer

Switching costs



**KNOWLEDGE AS A PRODUCT** |

# COST STRUCTURE

The cost of producing the first copy is extremely high

- The prototype always costs more than all the other copies produced after the original was developed.

The ratio of sunk costs is very high

Important role played by the moral costs

- Image, goodwill and well known trademarks have huge importance

Zero marginal cost

Basically

- the cost of the first copy is unusually high;
- the cost of the additional copies is unusually low.

# A HOLLYWOOD EXAMPLE

<b>Title of movie</b>	<b>Production cost (million USD)</b>	<b>DVD price (2013, USD)</b>
<b>Pirates of the Caribbean 3</b>	300	1.91
<b>Spider-man 3</b>	258	2.17
<b>Harry Potter and the Half Blood Prince</b>	250	6.66
<b>Pirates of the Caribbean 2</b>	225	5.0
<b>X-men 3</b>	210	1.83
<b>King Kong</b>	207	2.99
<b>2012</b>	200	3.77
<b>Titanic</b>	200	9.99

# INCREASING RETURN

Example: jets of airplanes

- the development of a new propulsion engine costs 2-3 billion dollars
- the reproduction of the already created jet only costs \$50-100 million

By increasing returns experts mean that as the number of copies sold increases, the average cost of the products keeps shrinking all the time. While in case of decreasing returns, the average cost will increase after a while, such turnaround cannot be experienced in case of increasing returns.

Increasing returns usually lead to disequilibrium on the markets.

# SUNK COST AND BEHAVIOURAL SCIENCES

Decision makers tend to be misled by sunk cost

## Example

- Wanna see your favourite actress, so you buy a theater ticket for a show featuring her for €200
- You are not particularly interested in theater shows, but rather in the actress
- A few hours before the show starts it is announced that the actress had fallen ill and will be replaced by someone else
- You also have the option to go to a party with your friends instead of watching the show
- Which option would you choose

# LOCK-IN AND PATH DEPENDENCE



# LOCK-IN AND PATH DEPENDENCE

**Lock-in:** when the customer originally chooses a certain product or technology, and the costs of changing to another product or technology is so high, that he has to stick with the original choice

**Path dependence:** the original decisions made in past determines for a very long time our further decisions in the future. If we buy a small garage, it will be quite difficult to change for a large car.

# PATH DEPENDENCE

- **First degree path dependence:** characterising a case when an event happened in the past affects decisions today and in the future
  - Choice between an old and a new technology
  - If the new one would result in a lower average cost overall, but the older one provides a lower average variable cost
  - Technology and environment
- **Second degree path dependence** can also be called as a situation of ‘What would have happened, if...’ type
  - that there is no perfect information
  - the options in the present are the same as they were in the past (when the original decision was made), however in the meantime it turned out that option ‘Y’ would have been a lot better decision than option ‘X’
  - Using your money to buy a house or to buy Euros in 2008
- **Third degree path dependence** can occur when the company uses a solution ‘X’ but evidence shows that it would be better to use solution ‘Y’
  - Someone uses a solution ‘X’ but evidence shows that it would be better to use solution ‘Y’ instead
  - Videotape format war: Betamax vs. VHS

# BARRIERS TO ENTRY AND TO EXIT

The barrier of entry to a market is a cost that has to be paid by any firm that wants to enter the market, but does not appear as a cost for those firms that already entered the market a long time ago

Porter (1990):

- Economies of scale: the new firm that joins the market cannot sell a lot of products in the beginning, and so it cannot take advantage from the economies of scale;
- Product differentiation: customers are used to the well-known brands, so they are only willing to switch to a new product and brand, if the price is a lot lower (and lock-ins can change that as well);
- Capital requirements: sometimes entering the market is only possible if a lot of capital is invested (and that capital may well be transformed into sunk cost over time);
- One time investment and education cost of introducing a new product;
- Lack of access to distribution channels;
- Cost penalties independent of size: some examples are the distant premises, the lack of state support, the unfamiliar technology;
- Government policy: the state can also be protectionist to protect the local firms.

# PRICING AND BARRIERS TO ENTRY

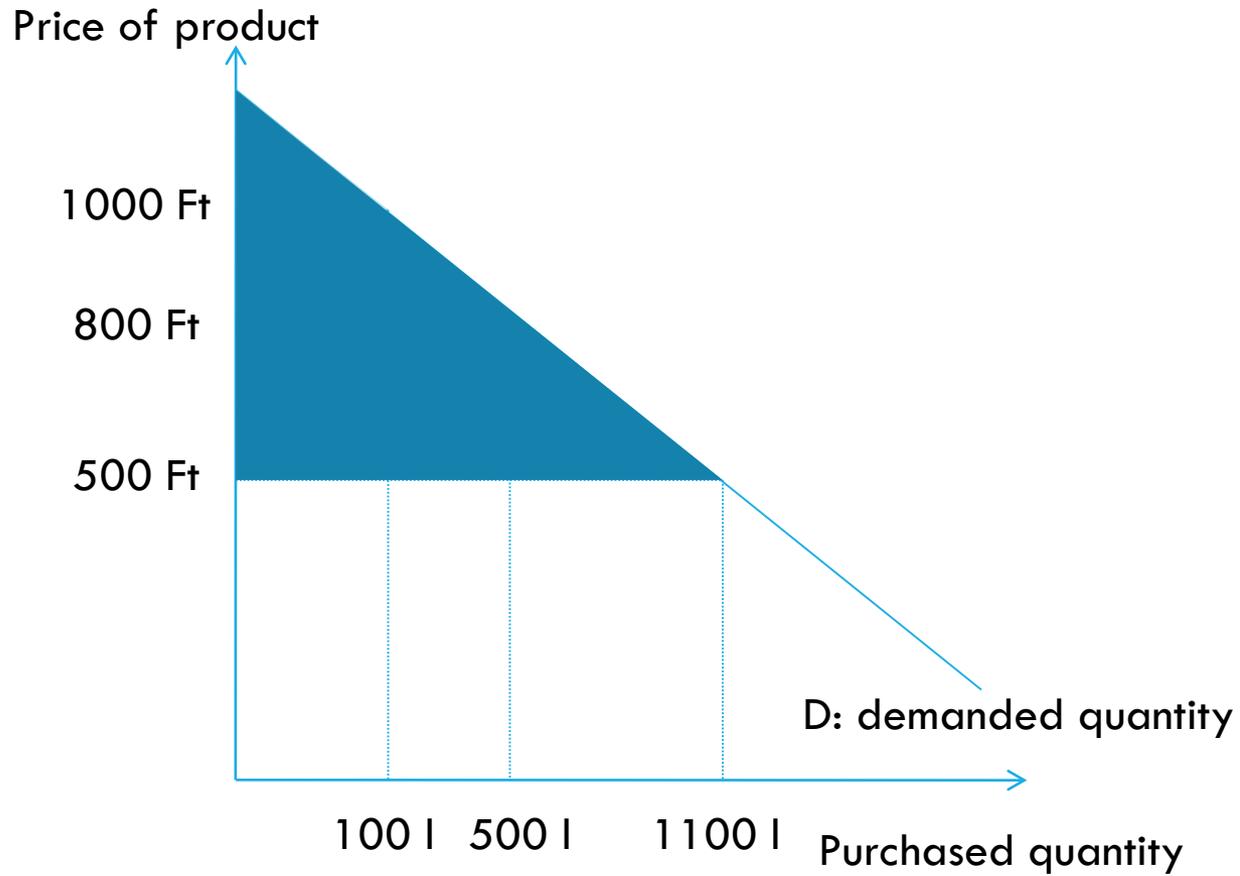
Year of introduction	Version number	Price (USD)
1985	Windows 1.0	100
1987	Windows 2.0	100
1990	Windows 3.0	150
1992	Windows 3.1	100
1995	Windows 95	80
1998	Windows 98	100
1999	Windows 98SE	150
2000	Windows 2000	300
2001	Windows XP	310
2006	Windows Vista	400
2009	Windows 7	300
2013	Windows 8	200

# PRICING OF KNOWLEDGE

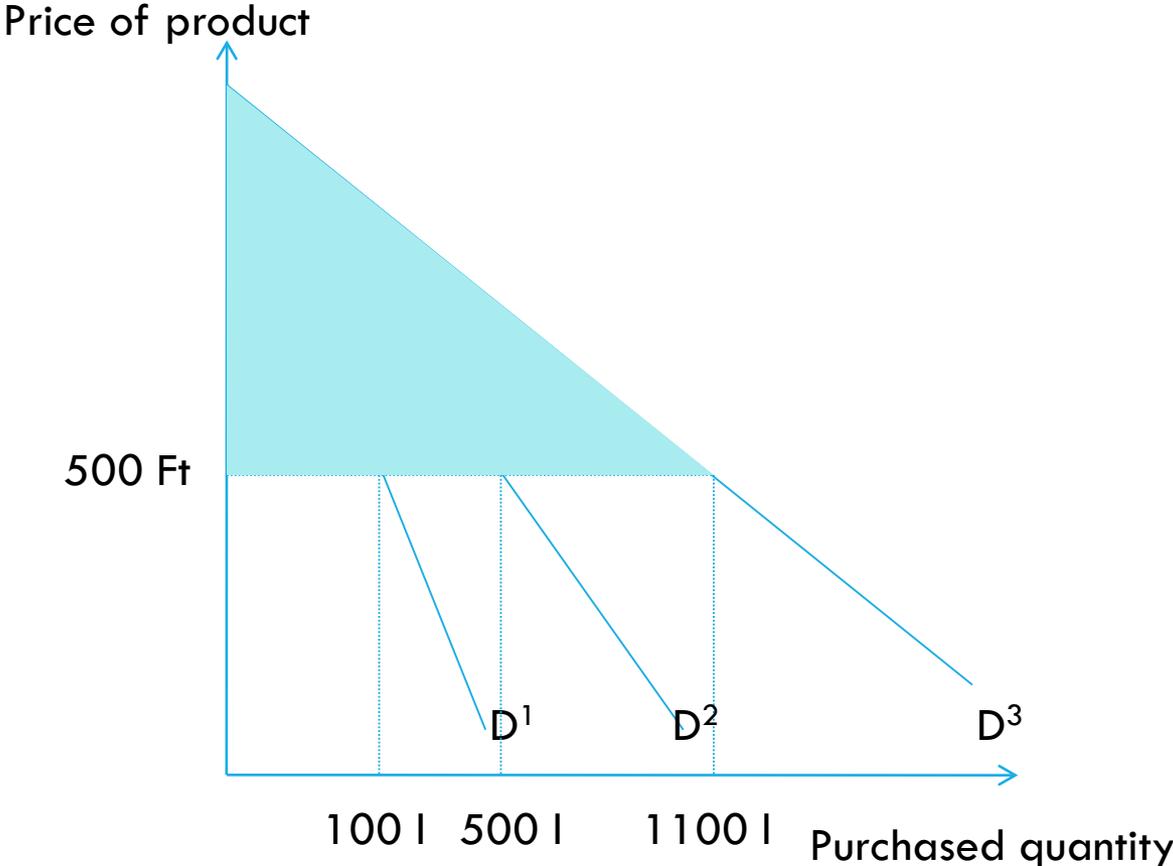
Reproduction costs of knowledge is often minimal (almost non existent)

So what price should one set to knowledge products?

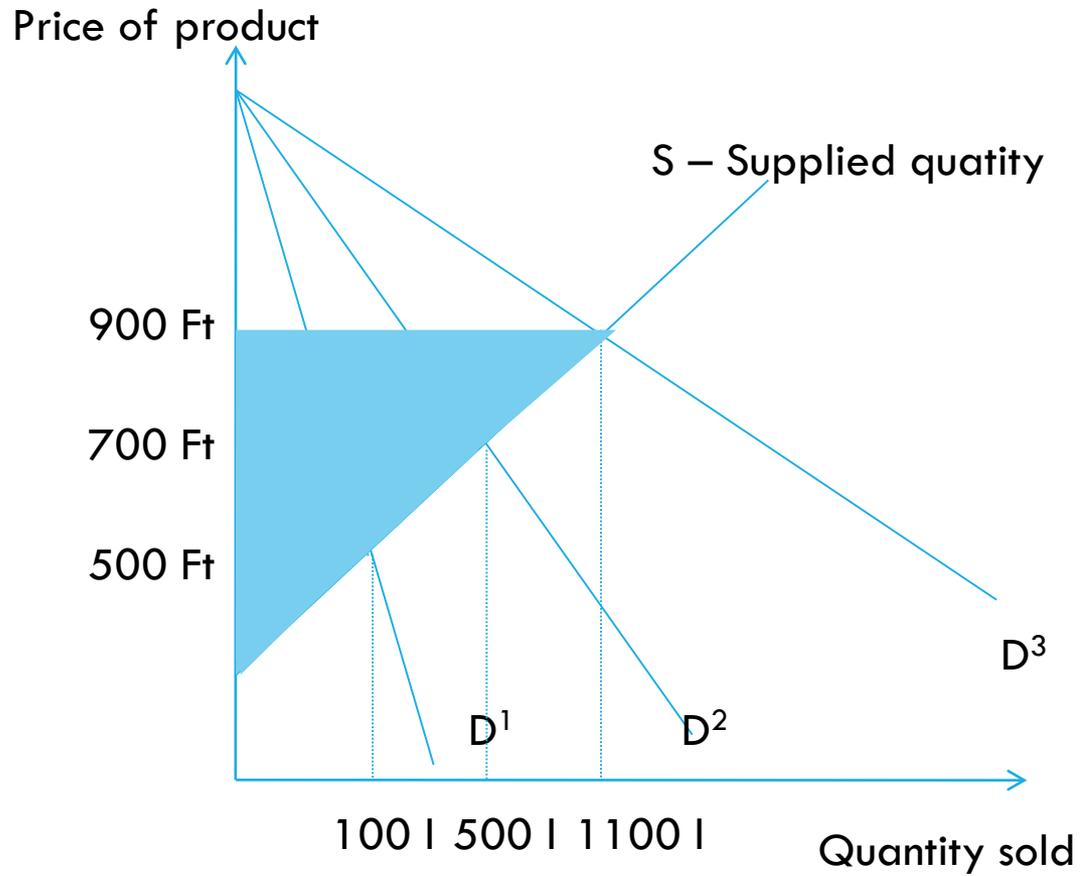
# CONSUMER SURPLUS



# PRICE SENSIBILITY



# PRODUCER SURPLUS



# MAIN POINT

The consumers would like to have as high a consumer surplus as possible.

Producers on the other hand would like to get as high a producer surplus as possible.

The company can only increase its producer surplus if the market price is raised,

that, on the other hand will lead to a drop in the consumer surplus.

# PRICE DISCRIMINATION

Price discrimination or price differentiation exists when sales of identical goods or services are transacted at different prices from the same company

## 1. First degree or perfect price discrimination

The price varies by customer's willingness or ability to pay: bargaining, individual profiling

## 2. Second degree price discrimination

The price varies according to quantity or quality sold

## 3. Third degree price discrimination

Group pricing: the consumers of a certain product are separated into different segments



# INDIVIDUAL PROFILING

Identifying each customer, and finding a way of learning about their preferences

Special offers

Plane ticket booking system

Online warehouse databases

# PRODUCT LINE

## Interested in the latest Batman movie?

- Visit the movie premier in New York ~ \$1000
- Wait for the first showing in your country ~ \$50-100
- Watch it in the cinema a few days-weeks after the premier ~ \$25
- Wait for video on demand services ~ \$15-20
- Buy it on DVD ~ \$10
- Watch it in the TV ~ free

# GROUP PRICING

Asking for different prices for the same product from different groups of people

- Regional-geographical price discrimination
- DVD region codes



# FURTHER OPTIONS FOR VERSIONING

Delaying – e.g. share price information

Operation speed and other characteristics

Functions

Product support

# PROMOTIONAL PRICES

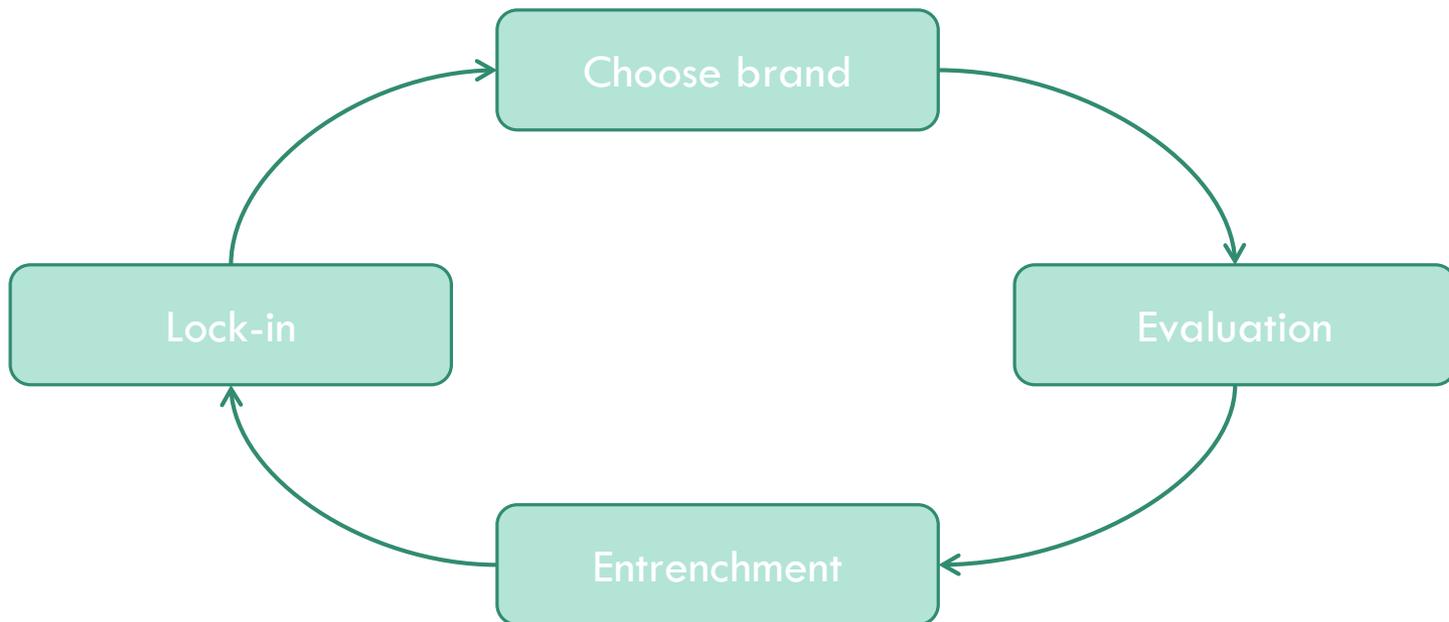
You can buy the product for a discount, but the discount is only available if some extra effort is made ~ only those will take it, who are extra price sensitive

Types:

- Sales discount
- Discount voucher
- Refunds

# LOCK-IN

A lock-in arises when the buyer and or/and the seller has to pay extra costs in order for the buyer to switch from the old product to a new one.



# TYPES OF LOCK-INS

## Long term commitments

- The lock-in is much more decisive, if several appliances were bought, and the expiration date is different.
- Renting, or leasing the appliance eases the lock-in of the buyer.
- If software is needed to operate the appliance, and those are also sold by the same company, the lock-in can get really tough.

## long term buying contracts

## brand-specific information

## data and databases

- Is your old database compatible with the new system?

## specialised contractors

## searching costs

## loyalty programs

# NETWORK EFFECT

If the value of a good is increased in the eyes of its consumers if the given good is used by more and more consumers, the network effect is in force.

Direct network effect may be observed if the value of a good increases whenever another user purchases the same good, or one, that is compatible with it: telephone network

Indirect network effect: the wealth of the users is only affected indirectly, because the number of users choosing the product can have an effect on the price of the supplementary products: iOS and its applications

Huge market concentration

# STANDARDS

Markets characterised by network effects and strong positive feedback, are ruled by standards

- They strengthen the network effects - Standards enforce compatibility (e.g. electronic plug in different countries)
- They limit uncertainty: choosing from rival, incompatible technologies
- They limit lock-ins - There is an inverse proportionality between the rate of standardisation and the rate of lock-ins

Compatibility may be achieved in many directions:

- outer compatibility: compatibility with the products of the competitors
- inner compatibility: compatibility with other versions of the same products, extremely with older ones
- future compatibility: shows that for how long can the compatibility be sustained.