

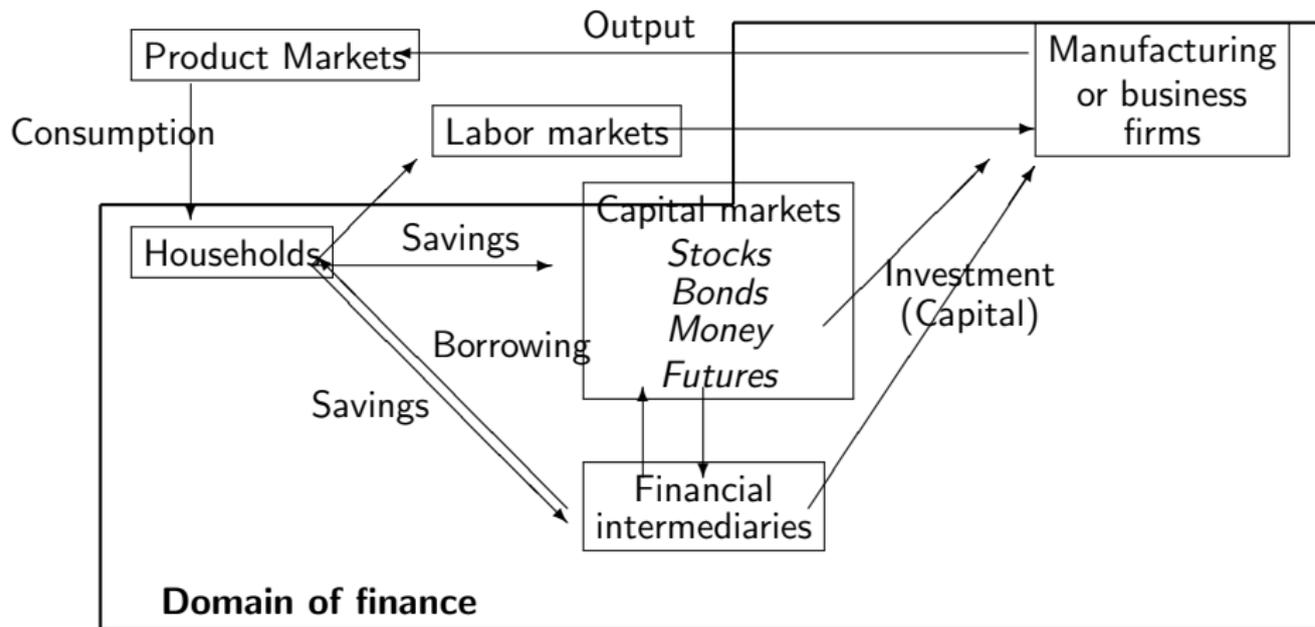
Tar robotene over finans? Er det framdeles bruk
for folk til å passe på pengene våre?

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Domain of finance



Source: Merton (1982)

Functional perspective - What does finance do?

- ▶ Clearing and settling payments.
 - ▶ Money, what to use?
- ▶ Pooling of resources, subdividing of ownership
 - ▶ The limited liability firm - the tool for the European takeover of the world.
- ▶ Transfer economic resources – Trading ownership rights.
 - ▶ Trading (listed) equities
 - ▶ Trading (listed) bonds
 - ▶ Private equity, etc...
 - ▶ Bankruptcy – “killing inefficient firms”
- ▶ Saving / Pensions
 - ▶ Investment Portfolio management.
- ▶ Managing risk
- ▶ Provide price information
- ▶ Dealing with incentive problems

Payment Processing

Raw Material: Cash

“Legal Tender,” – tokens of value (paper notes, coins) that everybody need to accept (by law).

Typically issued by a Central Bank.

Paper Money

Paper money issued in Bergen in 1695 by Jørgen Thormøhlen (Merchant).



Paper Money

Paper money issued in Norway in 1877 by Norges Bank (Norway's Central Bank).

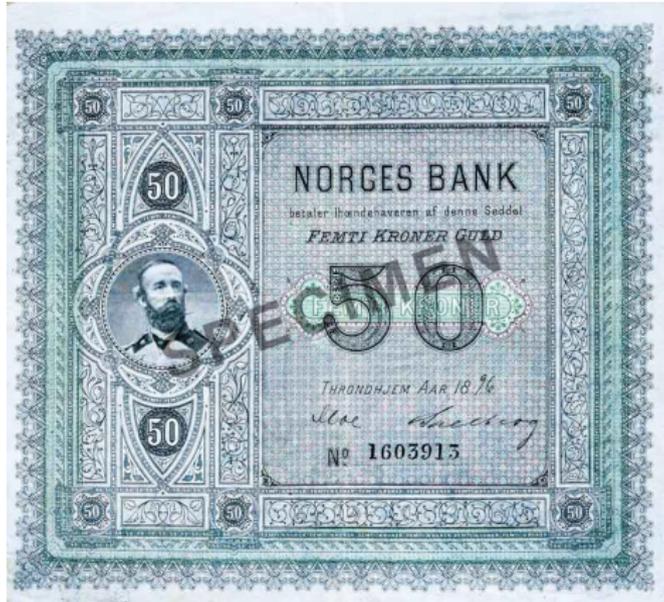


Photo Source: Norges Bank

Cash

Cash – Physical Transfer between owners
Labour intensive,
typically involves intermediaries.
Sør-Audnedal Sparebank.



Photo Source: Lindenes Bygdemuseum

Cash – Tellers

Bowery Savings Bank, New York City



Photo Source: Wikipedia

Cash

Note that bank notes is still typically the only *legal* tender, tender that one can legally *force* other people to accept.

Instead of physically handing over cash, the next step involves *promises* to hand over cash.

The **Cheque**



Cash

“From” account – “To” possessor of check

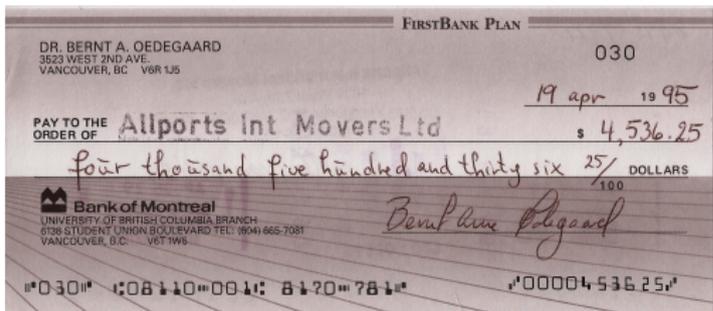
Still labour intensive - within bank confirmation, manual processing



Aslaug Pedersen, Sorting Checks, Manufacturers Hanover Bank, 1961

Cheque

In the US and Canada, checks still the most important method of transferring money.



(front)



(back)

Check Payment, 1995, Vancouver, BC, Canada.

Direct Bank Transfer

Next: Direct Bank Transfer (Bankgiro)

“From” account – “To” account

Initially – physical paper - like check

The image shows a blank Swedish GIRO form, which is a standardized document for direct bank transfers. The form is divided into several sections:

- Top Left:** A small globe icon and a box for "Betalingens formål" (Purpose of payment).
- Top Center:** The word "GIRO" in large letters.
- Top Right:** A box for "Betalingens belopp" (Amount of payment).
- Middle Left:** A box for "Betalt av" (Paid by).
- Middle Right:** A box for "Betalt till" (Paid to).
- Bottom Section:** A yellow horizontal bar containing a 12-digit "Kontonummer" (Account number) field. Below this bar, there are fields for "Kundidentifikationsnummer (KID)" (Customer identification number), "Kontor" (Branch), "Dns" (Currency), "Till konto" (To account), and "Bankens nummer" (Bank number).

Direct Bank Transfer

But gradually more fully electronic - enter accounts once, everything else automatic



Need a centralized computing facility to handle the within-account transfers, which typically are accounts of different banks.
Basis for transactions still: Legal Tender – ultimately – banknotes.

Bitcoin

Relative to the above, Bitcoin (and related technologies) are ways to move to a next step

- ▶ Is it possible to skip the need for banknotes as the legal basis for payments?
- ▶ When we transfer money, can we do it without bank accounts?

Bitcoin – fully electronic basis for monetary transfers.

Bitcoin

Bitcoin, the electronic equivalent of a coin:



Bitcoin

But, anything electronic can be easily copied.

How to be sure that the bitcoin we just got is not false?

For Bitcoin to work, a complete history of transfers of bitcoins between participants needs to be kept by “everybody” and one needs to

1. check that the person trying to do a transfer actually have bitcoins to pay with
2. once a payment is made, make sure that it is not possible for the payer to try to pay once more with the same bitcoin.

Automation

Manual task → Codified



Nordea vil kvitte seg med 6.000 ansatte og konsulenter

NTB · CAROLINE ENGE

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Vi bør ønske robotene velkommen | Bruce og Bernhardsen

JOACHIM BERNHARSDEN OG ERIK BRUCE, ANALYTIKERE I NORDEA

OPPDATERT: 14. SEP. 2017 10:44 | PUBLISERT: 05. SEP. 2017 21:15

AI DEBATT



But is the cash examples “robots?”

Algorithms and Robots

Algorithm: (Complex) Computer Program – A bunch of “What If” statements.

The designer of the algorithm need to have

- ▶ either thought of all eventualities up front
- ▶ or build in some flexibility, and the need to ask for human intervention

Algorithms are often linked with huge databases (Big Data).

Allowing for: *Training* the computer to recognize *patterns* in the data.

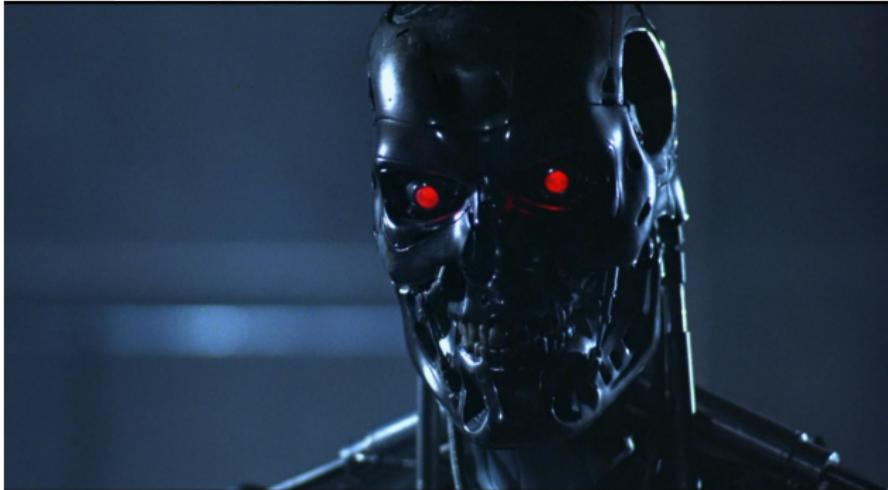
Move towards “Artificial Intelligence”

Where are we?

Somewhere on the range:

- ▶ Automating manual labour
- ▶ Using computers for (human) decision support
- ▶ Partially autonomous algorithms.
- ▶ Fully autonomous algorithms.
- ▶ Artificial Intelligence

Science Fiction's view of "robots" – Artificial Intelligence



Where are we in finance?

Example: High Frequency Trading in the Stock Market



Cover of Bør Børson, book by Johan Falkberget, Norway, 1920.

Joint Stock companies

Corporation is jointly owned by its equity owners.

A single share – fractional ownership

First modern joint-stock company: English East India Company, 1600.

Next innovation: Exchange trading of equities.

The Dutch East India Company issued the first shares traded on the Amsterdam Stock Exchange.

Basis for Europe's economic growth possible following the Middle Ages.

The technique of pooling capital facilitated investments in capital intensive industries, such as shipbuilding, railways and textile factories

The East India House 1817



Thomas H. Shepherd [Public domain], via Wikimedia Commons

What capital was needed for

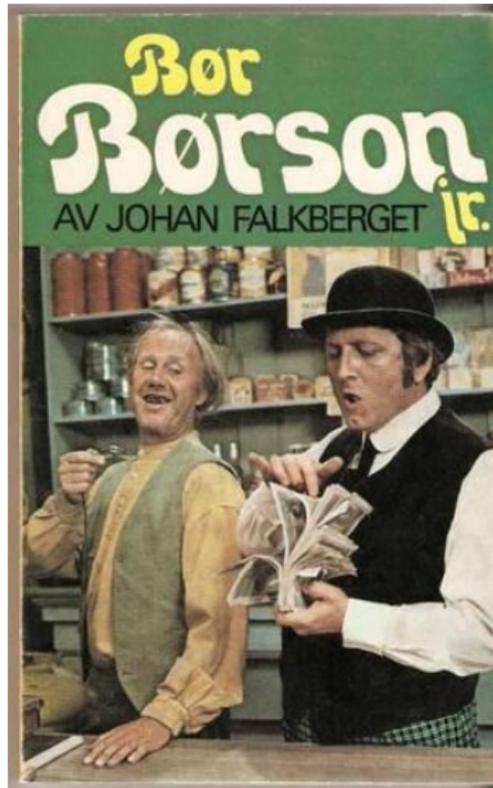
Shipbuilding:



By Francis Holman - The National Maritime Museum, Public Domain,

<https://commons.wikimedia.org/w/index.php?curid=22131652>

Norwegian's view of the stock market



Cover of Bør Børson, book by Johan Falkberget, Norway, 1920.

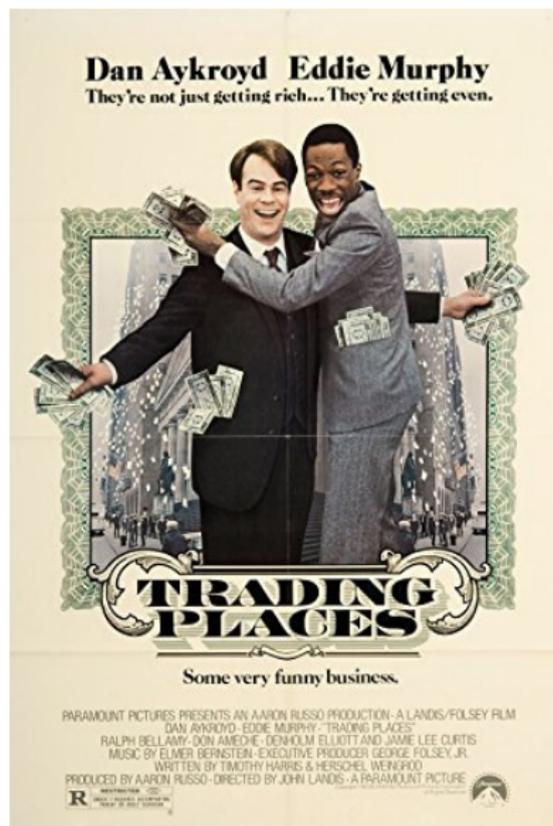
The evolving world of Exchange Trading

We are used to thinking about the NYSE as beehive of activity (this is in 1987).



New York Stock Exchange, floor in 1987 Photo Source: WSJ.

Traditional, manual operations



Colocation

As the computers are taking over, the floor of the NYSE looks like this:



New York Stock Exchange, floor in 2008. Photo Source: Wikipedia.

Computerization

Instead, the activity has moved across the river, to Mahwah, New Jersey, where NYSE has built its data center.



New York Stock Exchange, Move to Mahwah

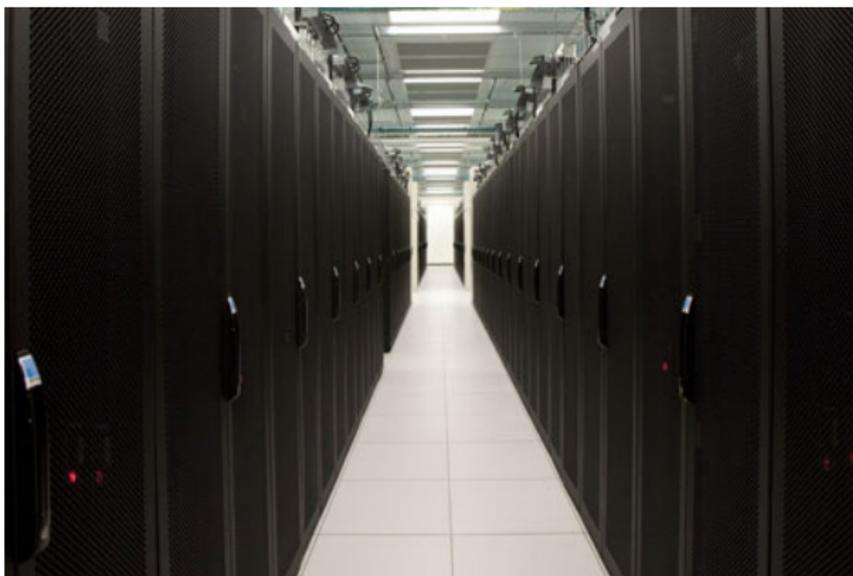
Computerization



New York Stock Exchange, Mahwah, NJ. Entrance

Photo Source: NYSE

Computerization



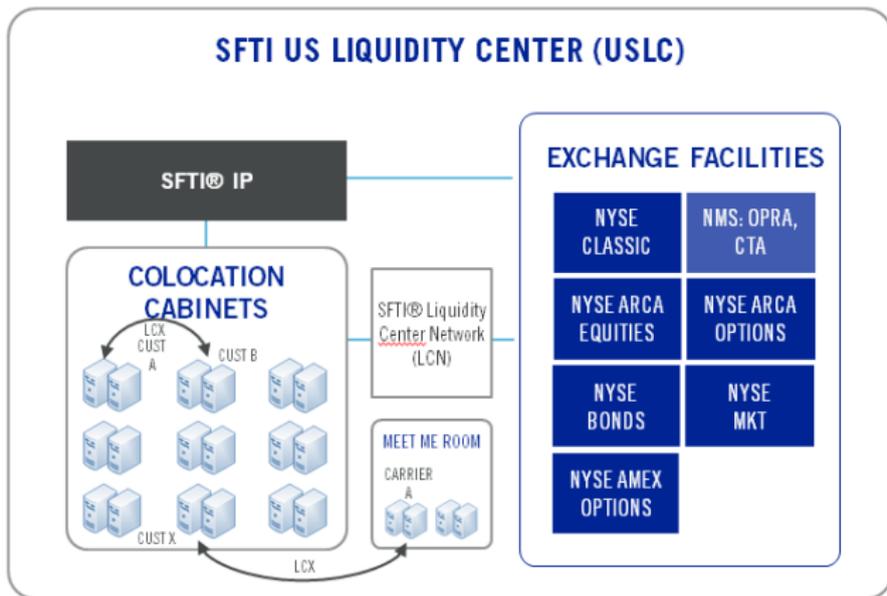
New York Stock Exchange, Servers, 2016

Photo Source: NYSE.

Colocation

Is a source of revenue to the NYSE.

How NYSE are selling their colocation services:



New York Stock Exchange Offer colocation to customers

Source: NYSE.

Consequence of HFT: The search for speed

HFT: Willingness to pay for infrastructure improving speed of data transmission.

Plot line in *Flash Boys*: Laying optical cable the straightest line between Chicago and New York

Optical cable lost out to **Microwave Towers** – line of sight, faster than optical cable.

Realization of speed advantage came in 2012.

The search for speed, ctd

Microwaves between New York and Chicago

New Applications for building microwave towers:

Before 2012

2012

10



FIG. 10: A map of 93,600 paths present in 187,338 microwave site-based license applications for the two years prior to September 1, 2012 (left) and of 191,290 towers culled from the FCC database (right). Colors indicate frequency bands: 6 GHz (black), 11 GHz (charcoal), 18 GHz (dark gray), and other (slate gray).

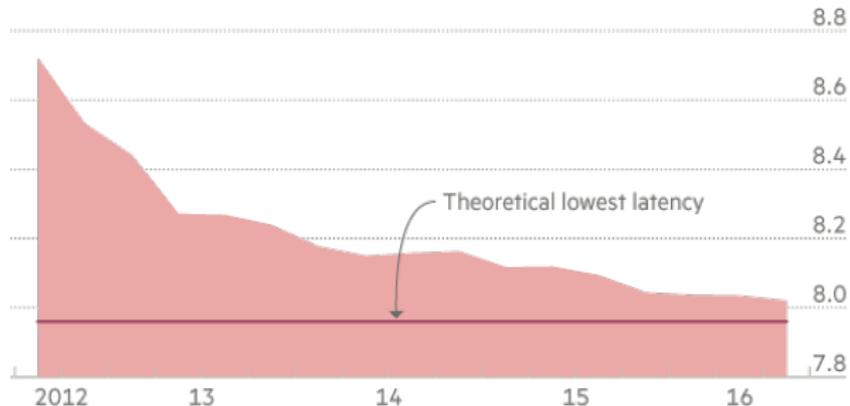
Figure taken from: Laughlin et al. [2014]

The speed race does however converge to a minimum decided by physics

Evolving latency Chicago-New York. 2012-2016

Roundtrip latency (time lag) on McKay Brothers
microwave route

CME in Aurora, Illinois, to BATS/Direct Edge exchange in Secaucus, New Jersey
(milliseconds)



Source: McKay Brothers

FT

Figure taken from *Financial Times*, 30 mar 2017.

Portfolio Management

Savings decision:

Two related decisions

- ▶ Asset Allocation – choice broad classes, such as bank saving, equities/funds, real estate.
- ▶ Portfolio allocation – within one asset class.
e.g. Which stocks/funds to invest in?

Automated investment strategies

Can robots take over portfolio allocation?

Already some applications

- ▶ Index funds – using automated trading to maintain a market weighted portfolio – autonomous trading – within limits.
- ▶ “Quant Shops” – “Big Data” – looking for patterns in equity returns that produces high returns. (Previously the job of academics...)

Robo Advisors

“there’s an app for that”

Automated investment advisors.

Log on to a web page, answer some questions about the purpose of your investment, and get suggestions about your portfolio composition.

Robo-advisor usually filed under the label of *FinTech*.

FinTech

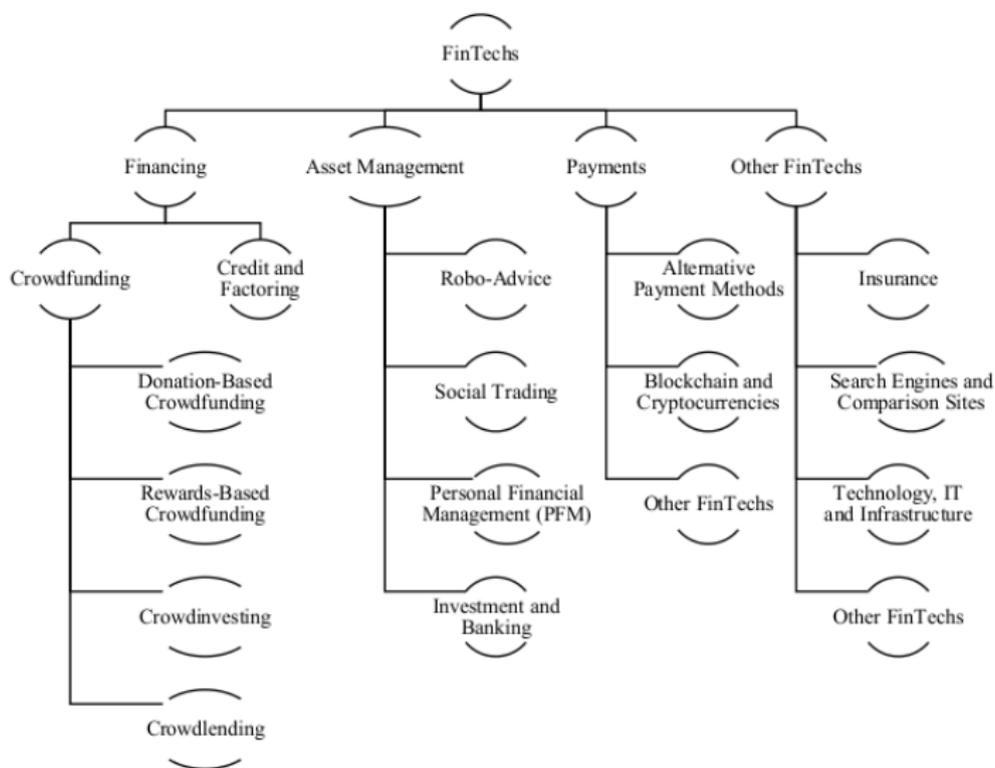
Collective term for *Financial Technology*, applying (IT) technology to financial applications.

Innovation driven both by

- ▶ Traditional financial firms (banks)
- ▶ Startups

A Categorization of FinTech

Figure 2: Segments of the FinTech Industry



The FinTech Cube

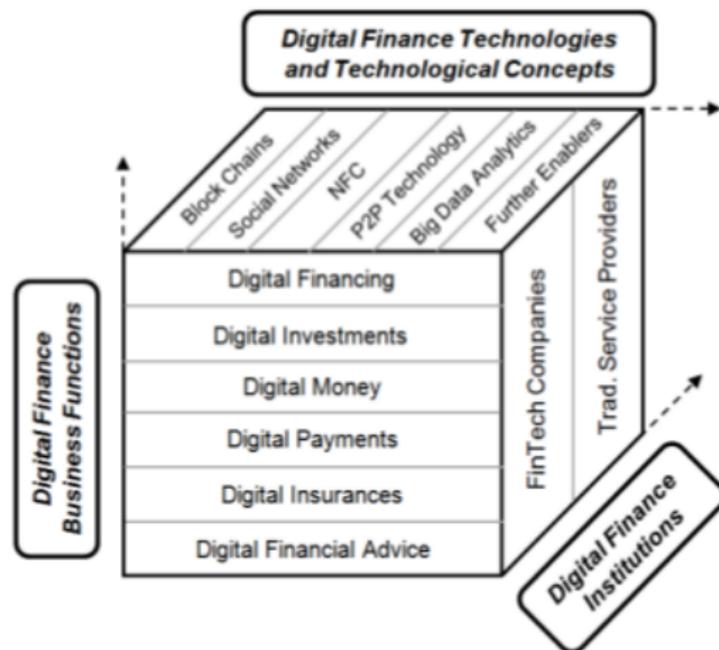


Figure 1: The Digital Finance Cube and its Dimensions.

Source: Gomber et al. [2017].

Conclusion

Where are we on the range

- ▶ Automating manual labour
- ▶ Using computers for (human) decision support
- ▶ Partially autonomous algorithms.
- ▶ Fully autonomous algorithms.
- ▶ Artificial Intelligence

Where may humans (still) have an advantage?

- ▶ Human interaction – advising / selling.
- ▶ Deep thought – figuring out complicated relationships that needs abstraction.
- ▶ Innovation – completely new ways of looking at things.

Gregor Dorfleiter, Lars Hornuf, Matthias Schmitt, and Martina Weber. The fintech market in Germany. Working paper, October 2016.

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