Global Financial Systems
Chapter 21
Technology

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To accompany
Global Financial Systems: Stability and Risk
http://www.globalfinancialsystems.org/
Published by Pearson 2013

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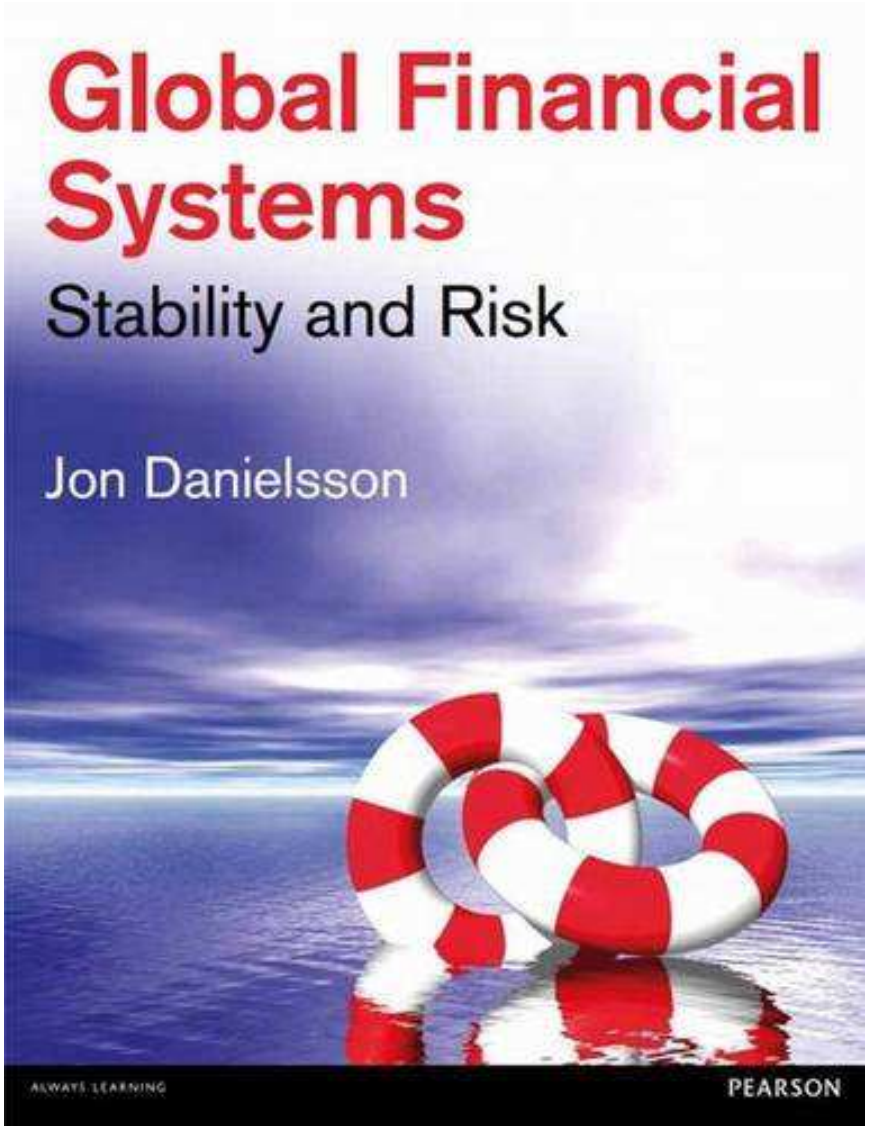
Book and slides



- The tables and graphs are the same as in the book
- See the book for references to original data sources
- Updated versions of the slides can be downloaded from the book web page

  `www.globalfinancialsystems.org`

Reading

- There is no other reading

Technology

- The financial system has always been one of the earliest adaptor of technology
  - Rothschild supposedly used pigeons to get advanced notice of Napoleon's defeat in Waterloo
  - semaphores (conveying information at a distance by means of visual signals)
  - telegraphs
  - computers
  - microwaves
- Now involves fintech, blockchain, cryptocurrencies, smart contracts
- It is hard to disentangle the computer science aspect from impact on society
- The below deemphasizes computer science as much as possible

Fintech

Creative destruction

- Dates back to Schumpeter in the early 20th century
  - The "gale of creative destruction" is the "process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one"
- How new ideas are continually changing how companies and industries work
- Implying that even if incumbents resist change, society should welcome it
- And that if the government gets involved with "industrial policy" it is more likely to entrench the incumbents and hinder creative destruction
- Even if the intention is otherwise

Digital disruption

- Spinoff of "creative destruction"
- Transformation of industries caused by new and emerging digital technologies and business models
- Digital disruption implies a small company with few resources successfully challenging the incumbents
  - Kodak
  - vs.
  - Netflix, Airbnb, Facebook, Alibaba,....

Fintech — financial technology

- The use of technology and innovation applied to new and better forms of financial intermediation
  - Includes mobile payments, money transfers, lending (like peer-to-peer), fundraising and asset management
- Promises more efficient and cheaper products for consumers
- And helps alleviate financial exclusion — The 2 billion people without access to financial services

Impact on industry

- Who?
  - incumbents (e.g. existing banks)
  - other companies (e.g. Amazon)
  - startups
- The incumbents have identified fintech as a first order threat and priority

See recording of Axel A. Weber, Chairman UBS,
LINK
www.systemicrisk.ac.uk/events/
interplay-markets-and-politics-public-lecture

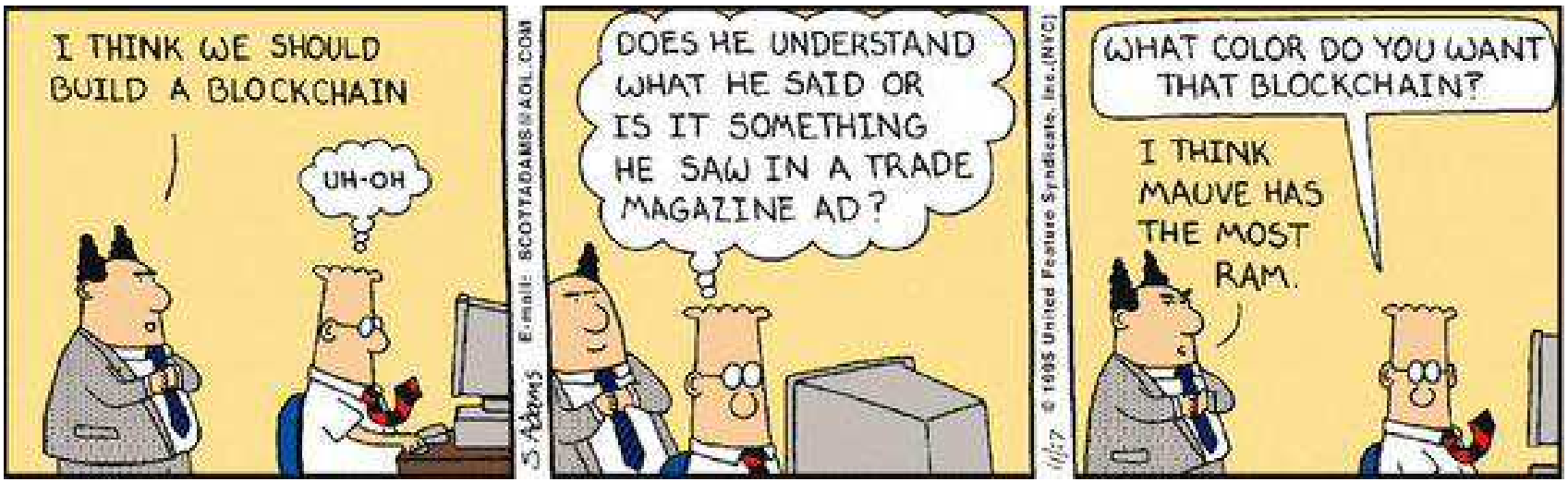
Official attitude

- All aspects of finance are heavily regulated
- Some aspects happened without the authorities noticing until too late
  - like Paypal
- Countries
  - enthusiastic supporters: Singapore, Sweden
  - others try to be: UK, Germany
  - and some are neutral or hostile: US, France, Italy, Japan
- Sandbox, a light and supportive regulatory framework for new entrants

Systemic/financial stability impacts

- Microprudential — increase competition
  - better for consumers
  - more scope for abuse
- Macroprudential — more heterogeneity
  - make system more stable
  - concerns about unknown risks
  - and migration of controlled risks away from regulated banks to less regulated sectors

Blockchain


I THINK WE SHOULD BUILD A BLOCKCHAIN
UH-OH
DOES HE UNDERSTAND WHAT HE SAID OR IS IT SOMETHING HE SAW IN A TRADE MAGAZINE AD?
WHAT COLOR DO YOU WANT THAT BLOCKCHAIN?
I THINK MAUVE HAS THE MOST RAM.
S. Adams
E-mail: SCOTTADAMS@AOL.COM
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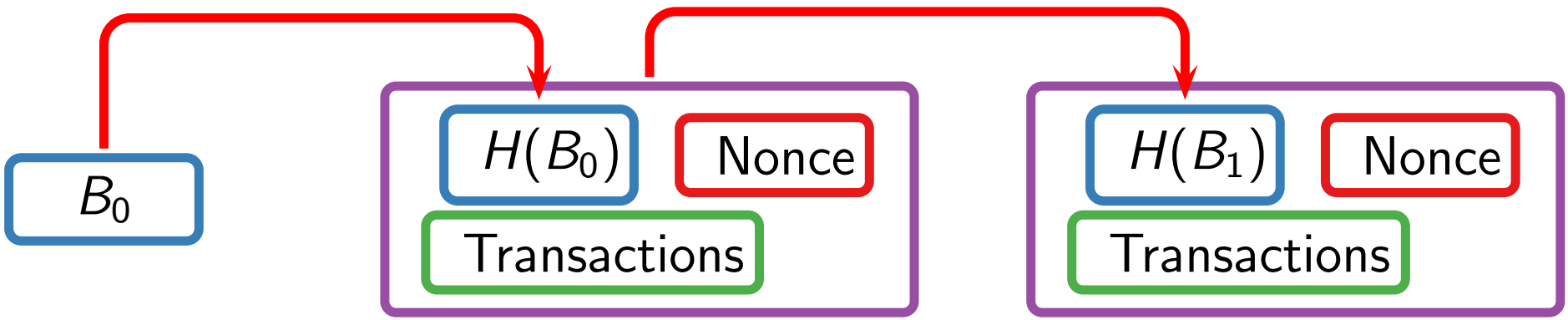
Trusting data

- Double entry bookkeeping solved the problem of trusting accounting books
- Records today are almost always kept in databases
  - accounting data, identity management, land registers, asset ownership,...
- That can be updated maliciously without anybody knowing
- What prevents that, creating trust, are institutions
- We trust institutions because if they cheat, they would forgo future profits/benefits

$$\text{profit from cheating} < \text{NPV future profits}$$

Blockchain

- Blocks linked in sequence. Each block has:
- An identifier of the previous block (i.e. a hash ($H(\cdot)$), see next slide), new transactions, a timestamp and Nonce (see slide after next)



Hash

- Unique summary of data that is always of the same length regardless of size of data
- A tiny change to block results in a completely different hash
  - Hash(London School of Economics)
    5b689d7052d4b5f65895b729c312d508
    Hash(London School ot Economics)
    a0d44554c91863cae84cad069a536b10

Accepting new blocks

- Anybody can conceptually add new blocks, except they have to meet a computational challenge — mining

$$H(B_i) < H(B_{i-1})$$

- Problem is:
- Find value X_i such that $H(B_i + X_i) < H(B_{i-1} + X_{i-1})$
- That value X_i is Nonce
- First person (miner) to find this X_i gets her block accepted
  - e.g. she has mined a bitcoin
  - in bitcoin, the difficulty level is increased (how much smaller the next block has to be compared to the current)

Protection against manipulation

- Suppose chain has 100 blocks
- And we want to manipulate block 50
- Then we have to change all the hashes for all blocks between 50 and 100
- And do this before anybody mines block 101
- Not economically feasible

Blockchain

- A new type of database (ledger)
- Designed so information cannot be surreptitiously changed
- The entire transaction history can be validated by anybody
- All data is public — complete transparency
- Consensus is attained by making the ledger publicly viewable and verifiable
- Publicly audit-able
- Kept in multiple places — decentralized
- Integrity is guaranteed by technology not institutions

Public blockchains or permission-less ledgers

- Open to the public and anyone can participate as a node in the decision making process
- All users maintain a copy of the ledger on their local nodes
- Use a distributed consensus mechanism to reach a decision about the eventual state of the ledger
- The majority of cryptocurrencies fall under this category

Private blockchains

- Proprietary blockchains are a subset of private blockchains
- Either
- Open only to a consortium
- Or
- Used within a single organization (not really useful)

Problems

- If all financial information was on a blockchain
- We would have full transparency and integrity
- The technological problem is
  - it is very costly, increasingly so as chain lengthens, to add blocks
  - entire chain has to be kept
  - blockchains scale very poorly
- Also, even if blockchains successfully used to keep track of information
  - typical example is land registry
- Will still need outside the authorities to enforce claims

Cryptocurrencies

Gold standard

- Most of the world operated on the gold standard between 1873 and 1914
- Printed money could freely be converted into gold
- High price and difficulty in mining gold meant that supply of money was controlled
- The advantage is stability
- The disadvantage is that the supply of gold did not keep up with economic growth — persistent deflation
- And the miners were creating money for themselves

Fiat money

- Money created by the government without any connection to real assets
- First example is China in the 13th century — printed too much
- Second example is Sweden in 1623 — printed too much
- The temptation to print too much is why central banks are independent

Cryptocurrencies

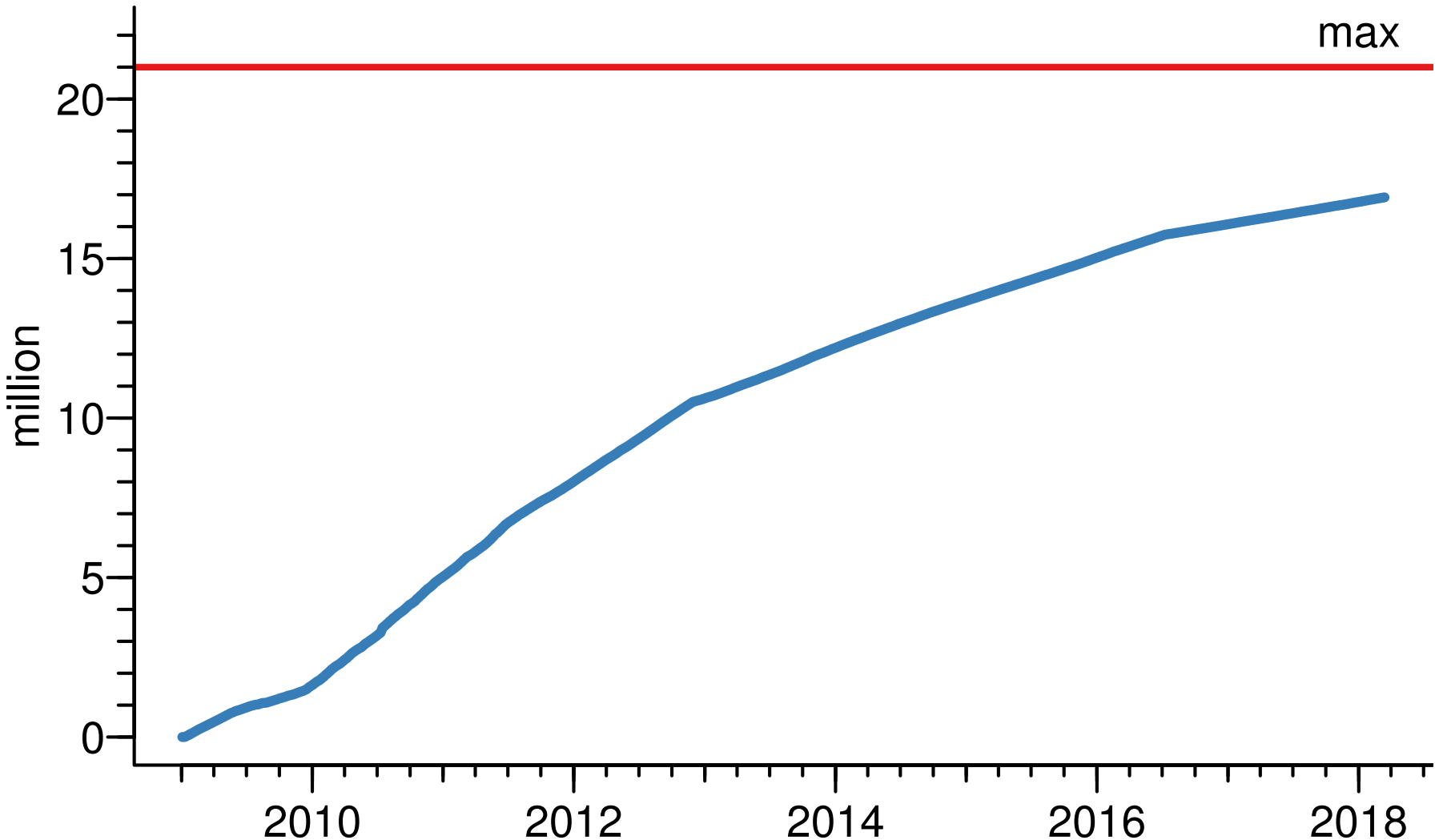
- My focus is on Bitcoin
- Replicate the gold standard with technology
- A computationally difficult problem whose solution means new money is created
  - finding Nonces
- The idea is that because supply is controlled, money is stable
- Money is not created by government and its integrity (trust) is guaranteed by technology
- Bitcoin, unlike some other cryptocurrencies, does not guarantee privacy (next slide)

Trilemma of trust, efficiency and privacy

- Trust in Bitcoin ensured by
  - Computational difficulties — takes 10 minutes to update chain to reflect transfer of ownership
  - Public visibility of chain
- To speed up transactions or get privacy
- Trust has to give

Bitcoin supply

all will be mined by about 2150



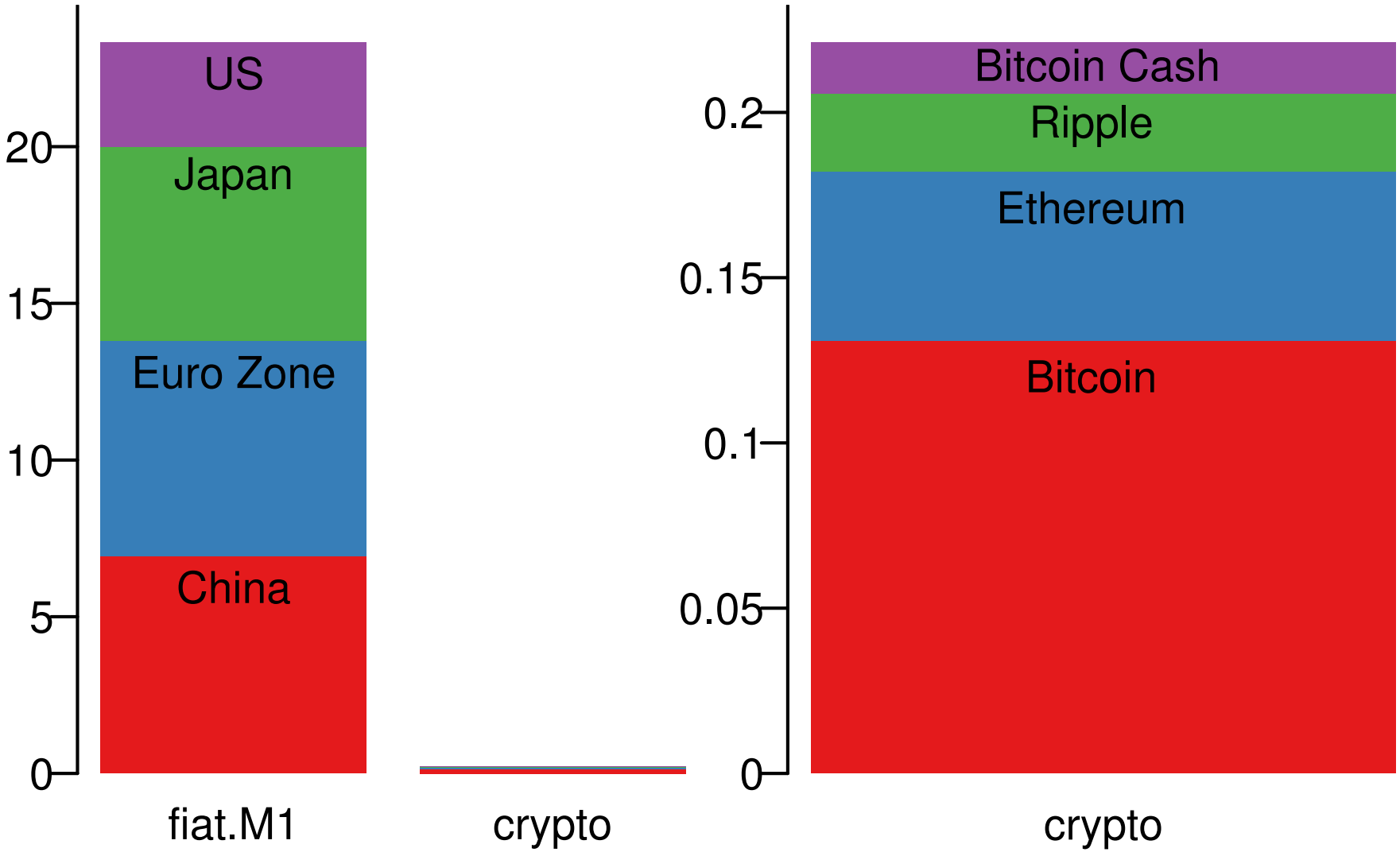
Main Issues

a. Adjust supply

- The main premise of cryptocurrencies is that they cannot arbitrarily be created by the government
- Often with references to QE or hyperinflation (Zimbabwe, Venezuela)
- And linked to "Austrian economic" ideas (Hayek in 1970s)
- In a country using modern monetary policy and credible central banking government is better to be able to adjust money supply
- Like we did in 2008, otherwise we might have ended up in 1929

Fiat M1 and cryptocurrency market cap

in USD trillions (10^{12}), June 2018



b. Fairness

- The total value of M1 in the four main economies is about $22 trillion, and much more if we take the rest of the world and or higher forms of money (M2, M3)
- Current market value cryptocurrencies is about $200 billion
- If cryptocurrencies replace Fiat money, speculators today will earn over 10,000% return
- And that would not be seen as fair by almost anybody
- And hence politically infeasible

c. Environment

- Mining is based on solving a computationally complex problem
- One that becomes more complex over time
- Uses 1% of world's electricity
- Environmentally disastrous

d. The incumbent technology

- We have very good incumbent technology — fiat money
- We can buy almost anything instantaneously at almost no cost
- Fiat money provides a stable store of value (-2% a year)
- For cryptocurrencies to take over, they need to show how they improve on fiat money
- And no good use case exists

Smart Contracts

Smart contract

- Self-executing digital contract
- Facilitate exchange of anything of value
  - e.g. money, content, property, shares, ...
- Most closely associated with Etherum, the second largest cryptocurrency

How they work

- Pre-written logic
- Stored and replicated on a distributed storage platform
- Executed by a network of computers
- That can result in ledger updates

Example: Instagram influencer

- Restaurant A contracts with instagram influencer B
- For each 1000 followers gained each month, A gives B 2 ETHs (Ethereum)
- For each 1000 followers lost every month, B gives A 3 ETH
- The contract is valid for one year

Beyond toy examples

- Conceptually can write a smart contract on anything that can be digitally delivered, verified and enforced
- So far, few if any examples of something that is not a toy example
- Real-world contracts often involve real goods and services, human verification and enforcement in regular courts
- It is an open question how that can be translated into a smart contract