Digital money
and the theory of money as memory

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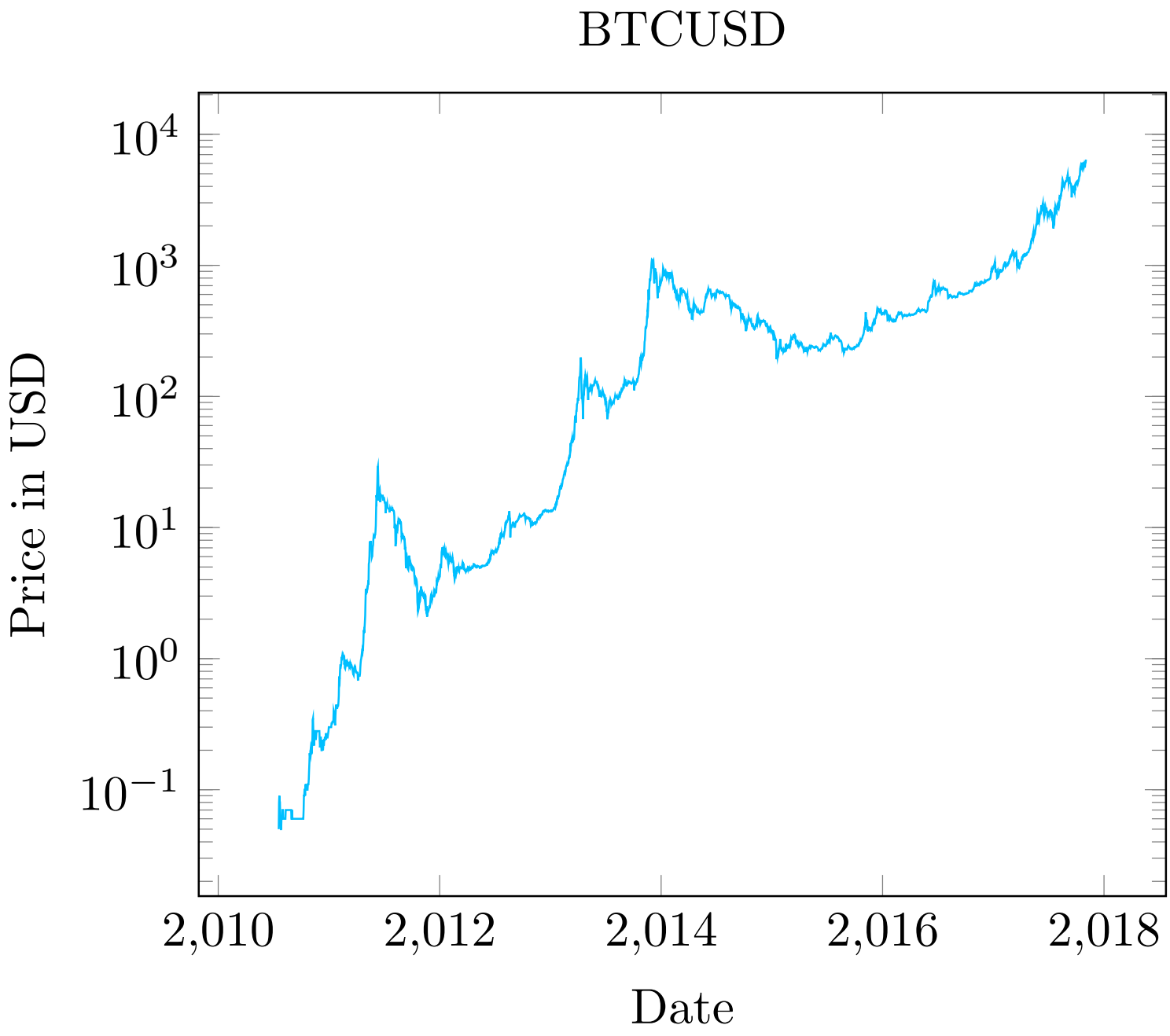
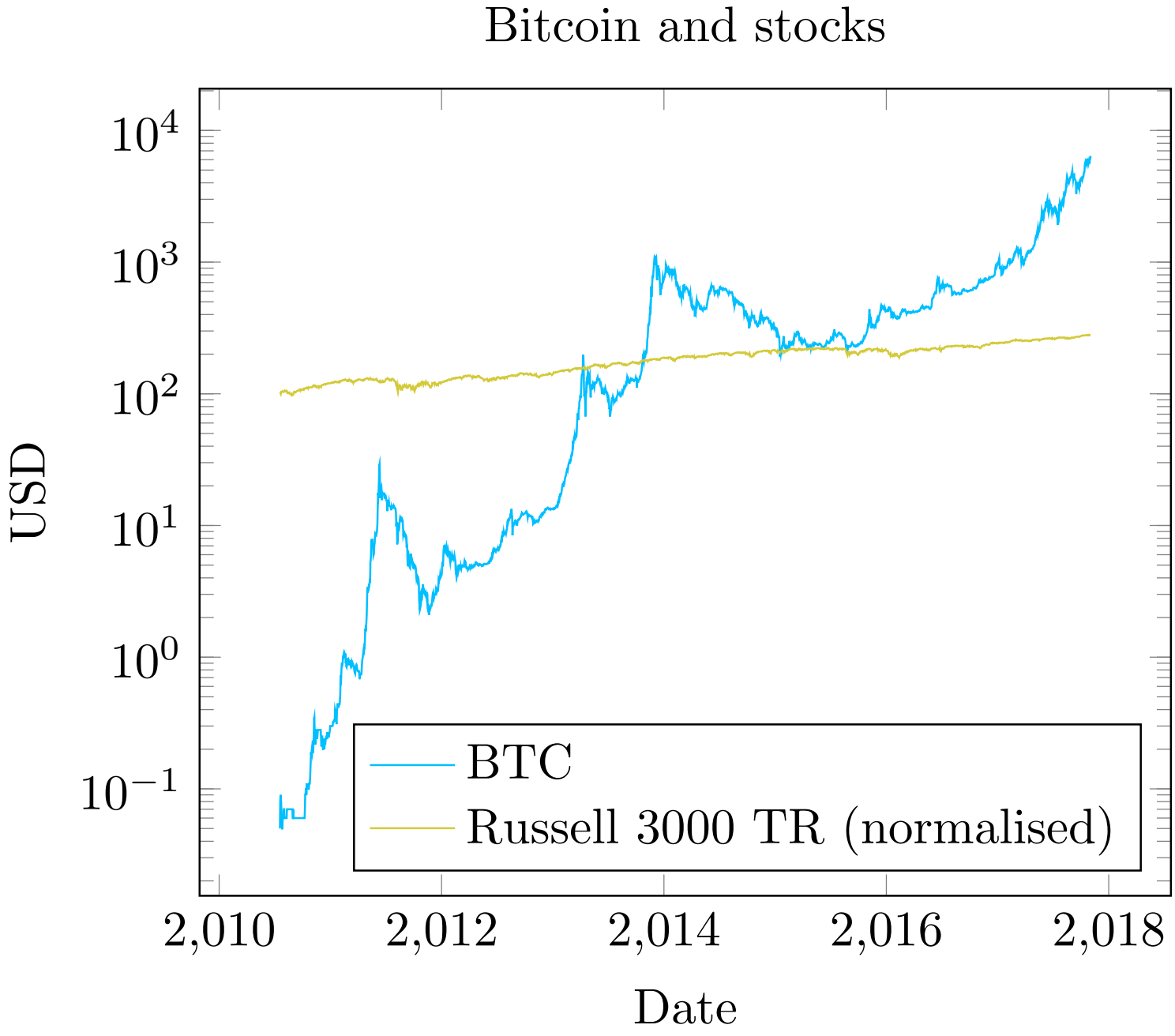

BTCUSD
Price in USD
10^4
10^3
10^2
10^1
10^0
10^{-1}
2,010
2,012
2,014
2,016
2,018
Date


Bitcoin and stocks
USD
10^4
10^3
10^2
10^1
10^0
10^{-1}
BTC
Russell 3000 TR (normalised)
2,010
2,012
2,014
2,016
2,018
Date

Bitcoin

- Transaction ledger is decentralised/permissionless (blockchain).
- Transactions are verified by consensus.
    - You can attempt to edit the ledger, but unless a consensus forms around your edit, it will be overwritten.
    - Proof of work.
- Verification of transactions / consensus building is rewarded by the issuance of a fixed decreasing number of new coins constantly issued (mining).
    - Competitive / rivalrous

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Bitcoin - technological efficiency

- Adam Smith argued that the gold standard was inefficient, as it encouraged socially useless gold mining.
- Same logic applies to bitcoin mining.
    - Proof of work verification is much more computationally demanding than just having a permissioned ledger (like a spreadsheet).
- Fiat money much less expensive.

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Bitcoin - technological efficiency

- Transactions are costly.
- Before a recent *fork*, the bitcoin network could only handle about 10 transactions per second.
- This has improved, but still a long way behind payment systems that do not require permissionless consensus.

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Bitcoin - store of value

- No real anchor.
  - The real price of gold is (hopefully) somewhat influenced by consumption / production MRS and productive MRT.
  - No technical upper or lower bounds on the marginal resource cost of mining.

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Before proceeding, a word of caution

Money is something of an embarrassment to economic theory.

Banerjee and Maskin (1996, QJE)

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Old view: solves double coincidence of wants problems

- Traditionally taught in first year economics textbooks.
- Money is "acceptable", helps people with different endowments trade.
- Instead of trading fish for apples, you trade fish for money then money for apples.
- Some problems with this theory.
    - Debt precedes money. (David Graeber *Debt: the first 5000 years*).
    - We don't use money in family life, but we still have double-coincidence-of-wants problems.

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    - We don't use money in family life, but we still have double-coincidence-of-wants problems.
    - Instead, we remember.

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New view: money as memory

- Economic theory stresses the role of money as a memory technology.
- Money balances stand in place of ledgers of past interactions between people.
- Money is a summary of histories.
- This view was formalised by Kocherlakota (1998, JET).

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New view: money as memory

[A]ny allocation that is achievable using money alone could be achieved instead by allowing agents costless access to a historical record of past actions that I term memory; I conclude that the role of money is to serve as a (typically imperfect) form of memory.

Kocherlakota (1998, JET)

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Money as memory

We can think of 'traditional' money as taking one of two forms:

- Cash/currency
- Bank deposits

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Money as memory

We can think of 'traditional' money as taking one of two forms:

- Cash/currency
  - As a memory technology, cash is very crude. Cash doesn't retain memory of its travels from hand to hand. Cash is *anonymous*.
- Bank deposits
  - Bank money typically provides more 'memory', in the form of the bank ledger. This ledger records how current balances are the result of prior transactions. Bank money is *nonanonymous*.
  - This 'memory' is maintained by individual banks with a single point of entry ledger.

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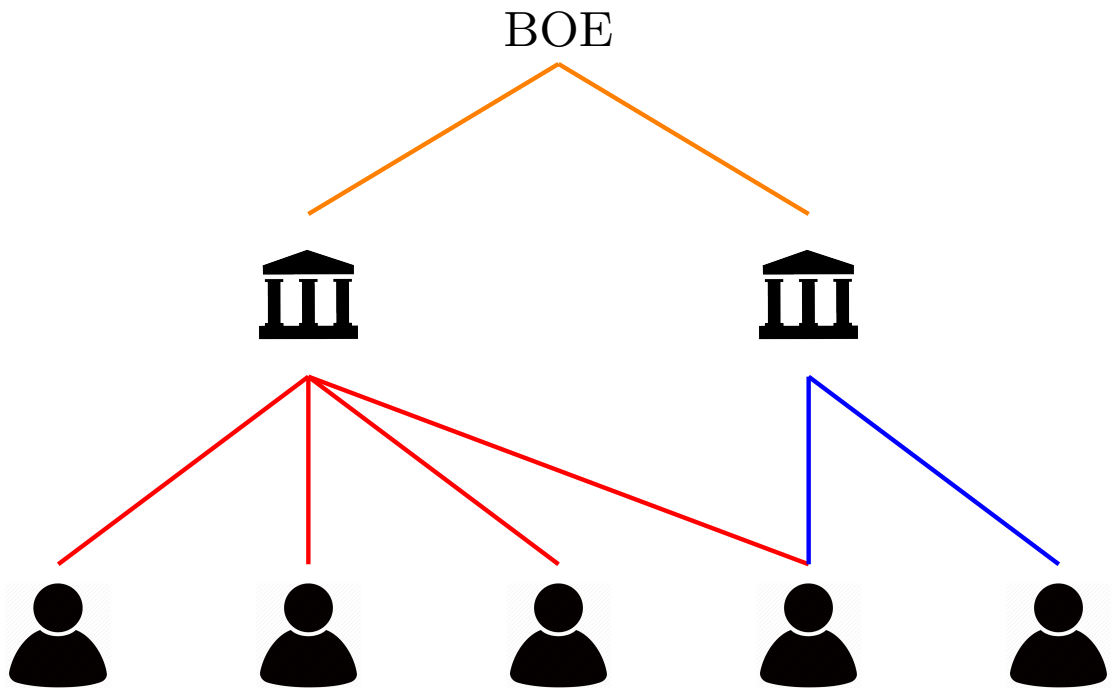
Ledgers



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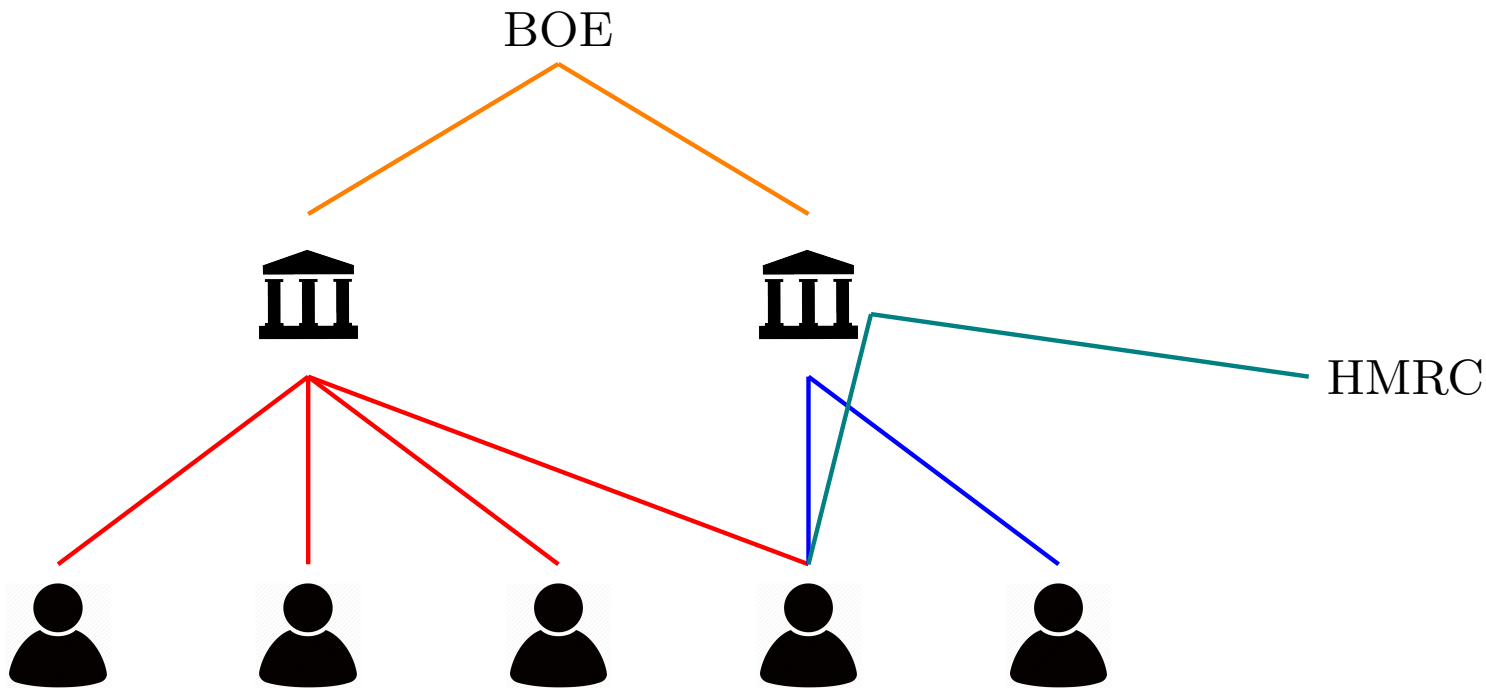
Ledgers



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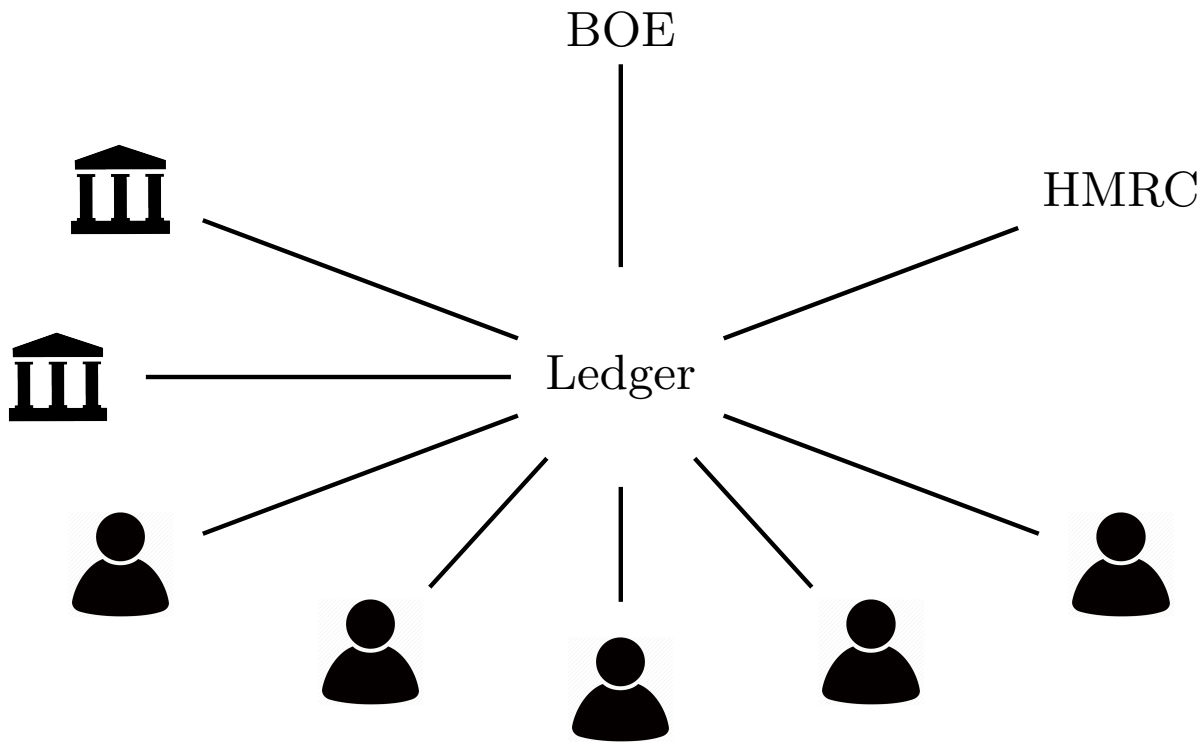
Ledgers



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Money as memory

Is digital money different?

- Bitcoin appeared to offer a cash-like service for electronic transactions.
- In order to avoid a centralised ledger (as in bank money) the blockchain technology that underpins bitcoin distributes transactions across a distributed ledger, validated by a dispersed network of miners.
- The technology that underpins *anonymity* for bitcoin also distributes the histories of transactions.
- In this way, while bitcoin was intended to be cash like, with no memory, the blockchain itself is a memory technology.
- Anonymity is a design choice rather than an implication of the technology underlying bitcoin.
- The blockchain technology underpinning bitcoin offers a wider array of combinations of memory and anonymity than were previously available with traditional forms of money.

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Is money with more memory better money?

There are strong arguments in favour of nonanonymous money:

- It is easier to collect taxes when money is nonanonymous, when monetary systems keep a lot of memory about account holders identities and transactions.

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There are strong arguments in favour of nonanonymous money:

- It is easier to collect taxes when money is nonanonymous, when monetary systems keep a lot of memory about account holders identities and transactions.
- Some forms of financial crime, for example money laundering and mugging, are more difficult to deter when money is anonymous.
- Economic theory argues that the efficiency of insurance and loan markets could be improved if it were easier to link contract terms to other transactions (see Kilenthong and Townsend, 2014 and Chiu and Wong, 2015).
    - An example that happens in practise is the bundling of health insurance with gym membership subsidies. This reduces moral hazard by encouraging the insured to keep healthy.
    - But, in general, it can be difficult to enforce this bundling of financial contracts with retail price distortions. Individuals can typically hide their consumption from the insurance company.

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Is money with more memory better money?

And also some arguments against:

- People prefer to use more anonymous monetary systems.
- It is not always the case that more memory reduces financial crime:
  - Kahn et al. (2005, IER) argue that there is a link between the greater use of bank money in recent times and increases in identity theft. In their model, monetary systems with greater memory can reveal certain individuals as targets for identity theft.
  - Awaya and Fukai (2015) show that some forms of memory inherent in monetary systems can be gamed by strategic individuals, increasing costs associated with adverse selection.

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Summary

- The blockchain is a memory technology.
- Distributed-ledger based monies present opportunities to make different choices about the anonymity of economic interactions.
- Different choices about which elements of the history of transactions can be distributed and to whom (national tax authority, foreign tax authorities, counterparties ...).
- There are likely to be conflicts between which forms of money individuals would want to use, and which forms are preferable socially.
- There are important trade-offs surrounding the costs and benefits of nonanonymity and the distribution of transaction histories to third parties.

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