Lecture 4: digital currency and central banking

Course on Central banking, City University, Feb 2019

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Recap

- Lecture 1:
  - how central banks and money are often at the centre of major political events in history.
  - Monetary stability requires political stability, often lacking.
- Lecture 2:
  - Monetary and financial stability functions of central banks; central bank independence.
- Lecture 3:
  - Causes of the financial crisis of 2008 and responses to it.

Digital currency: harmful bubble or challenge to central bank money?

1 Bitcoin equals

3,583.67 United States Dollar

13 Feb, 13:04 UTC · Disclaimer

1 | Bitcoin

3583.67 | United States Do

Source .

Overview of lecture 4

- Digital currency as a challenge to central banking in the future.
- What are digital currencies?
- Could they supplant central bank currencies?
- Would it be a good thing if they did?
- Should central banks provide digital currencies?
- What would happen to monetary and financial stability policy if digital currencies took over?
- How would a crisis of 2008 play out if we had private digital currencies instead?

Reading

- Blogs [here and here] by David Andolfatto, St Louis Fed, also his slide show.
- Ben Broadbent, BoE's DG, 2016 speech 'Central banks and digital currencies'
- BoE QB: Ali et al 'The economics of digital currencies', 2014
- BoE QB: Ali et al 'Innovations in payment technologies and the emergence of digital currencies', 2014
- LRB, John Lanchester 'When Bitcoin grows up, where is money?', 2016
- Yates, 2017 'India's reverse helicopter drop', FT Alphaville

More reading

- Viri Lehndonvirta, OII, ‘The blockchain paradox…’
- ‘The plan to unite Bitcoin with other online currencies’, Stefan Thomas, Wired.
- Various posts on FT Alphaville; also follow @izakaminska, @DavidKeo, @M_C_Klein

Even more reading

- Sule Halpern: Bitcoin mania, NYRB
- Intro to crytocurrencies, Berentsen+Schar, FRB St Louis Review
- Satoshi Nakamoto, Bitcoin: a peer-to-peer electronic cash system. This was the original 'white paper' that started it all off.
- Oditorium blogs:
  - http://www.oditorium.com/ou/2013/04/why-bitcoin-will-never-be-a-good-store-of-value/
  - http://www.oditorium.com/ou/2013/03/economics-of-bitcoin-mining/

Yet more reading

- Black, ‘Hashcash…’.
- Yates ‘ The consequences of allowing a crypto currency takeover’, FT’s Alphaville.
- Yates ‘The Assignat and the Petro’ FT Alphaville.

Our perennial Utopian/Dystopian technology preoccupations

Elements of the distracting digital currency mystique

- Pseudonymous creator of Bitcoin: ‘Satoshi Yakamoto’
- False revelation by Australian computer programmer, Craig Stephen Wright, or was it?
- Cryptography; distributed remote computing on the internet
- Fraud in Bitcoin exchanges
- Disputes in the Bitcoin communities
- ‘Forks’ in the Bitcoin blockchain [BTC cash, BTC…].

Pitfalls of the Bitcoin commentaries

- Poorly understood technology
- Allows us to fantasise or worry about Utopian or Dystopian transformation, sometimes simultaneously.
- Other examples: AI, machine learning, driverless cars, robots, dark-web.
- Easy to dismiss digital currency as a topic for fantasists, and miss that it might be a genuine challenge or opportunity for central banks.

WHAT IS BITCOIN?

What is Bitcoin?

- Intrinsically worthless, zero-interest, steal-able, private electronic currency
- The largest, and first of about 30 competitor e-monies:
  - Litecoin, Ethereum, Fatcom, Vertcoin, Zcash, Auroracoin, Dash, Blackcoin, Burstcoin,Dash, Dogecoin, Digitalnote, Gridcoin, Monero, Mazacoi, Stablecoin [pegged to US$]

How do you get a Bitcoin ?

- From an ATM [?]
- From a Bitcoin exchange [recall high profile cases where exchanges collapsed because of fraud, hacking, mismanagement].
- Download an app that allows you to create a ‘wallet’.

A bitcoin ATM

What is Bitcoin?

- 30MB of open-source, C++ code [=many,many telephone directories if you printed it all out]
- Digital file: ‘wallet’ recording quantity of Bitcoins
- Distributed ledger: list of entire history of agreed transactions from one wallet to another
- Protocols for verifying a transaction, agreeing that a transaction has been verified, and agreeing who can verify.

Bitcoin miners are not miners

Bitcoin ‘mining’=activity of verifying a transaction [not ‘finding new Bitcoins’, so not what ‘mining’ is to gold.]

Miners get an agreed reward for being the one who successfully has a proposed verified transaction agreed.

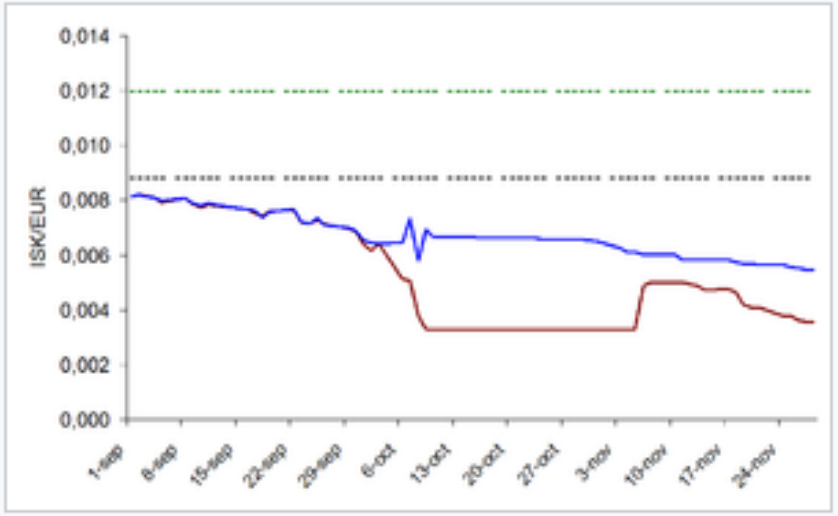
The reward slowly declines over time, hence number of Bitcoins asymptotes to a fixed number.

Bitcoin compared to other monies

- Specie: valued commodity
- Physical fiat currency=paper or metal object that used to be a claim on specie, but is no longer.
- Electronic bank deposits: digital record of a claim on a bank to reimburse you on demand with physical currency
- Bitcoin: variable output of a bunch of open source, agreed C++ functions.
- Can’t ever hope to touch it or feel it.

Variable value of Bitcoin and other monies

- Some contend that Bitcoin cannot function as a money because its value varies. But this is a question of degree.
- Specie fluctuates in value relative to money and goods.
- Paper money fluctuates according to monetary regime, health of banks and sovereign liability to banks
- Bank deposits fluctuate in value according to the health of banks [often in a binary way].
- Bitcoin value fluctuations not qualitatively different.
- 2 examples of fiat currency fluctuations we covered already; reminder follows:



The decline of the Icelandic króna against the euro, shown from September to November 2008. The lower solid line (in brown) shows the offshore rate as quoted by the European Central Bank; the higher solid line (in blue) shows the onshore rate as quoted by the Central Bank of Iceland. The two solid lines diverge on 6 October, after Glitnir had defaulted on some wholesale depositors in the UK, although there had been unusually large differences (up to 5%) during the previous week. The lower dashed line (in black) shows the average rate from January to August 2008 (113.31 krónur to the euro, already down from 91.2 krónur to the euro on 31 December 2007), while the upper dashed line shows the long term average from 1999 to 2007 (83.423 krónur to the euro).

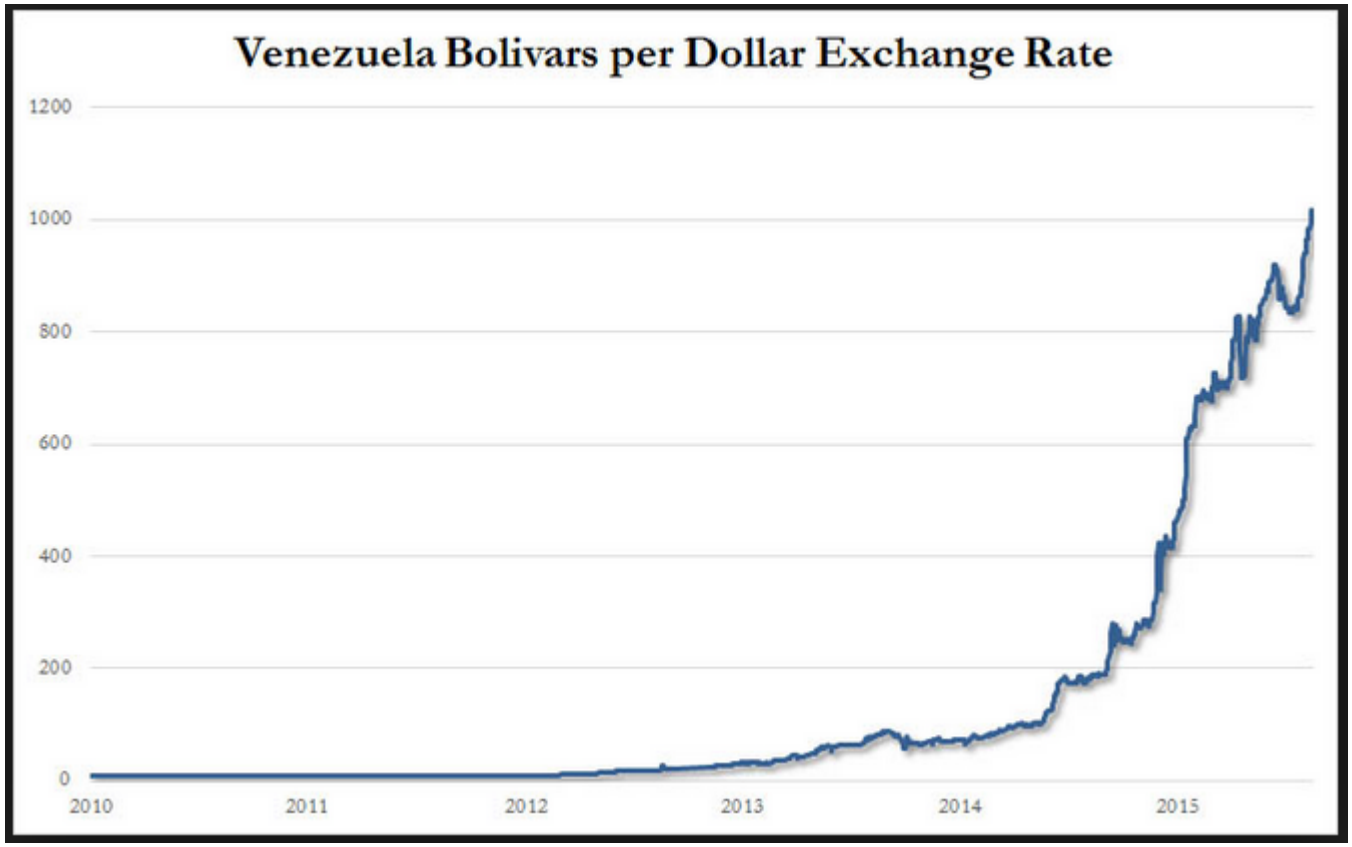
Icelandic financial crisis.

Markets worried about the health of Icelandic banks which had defaulted on some of their borrowing.

Icelandic kroner falls in value.

Markets think maybe Iceland would be forced to print kroner to finance a bail out, or make up for lost tax revenues in a recession.

[And other reasons perhaps].



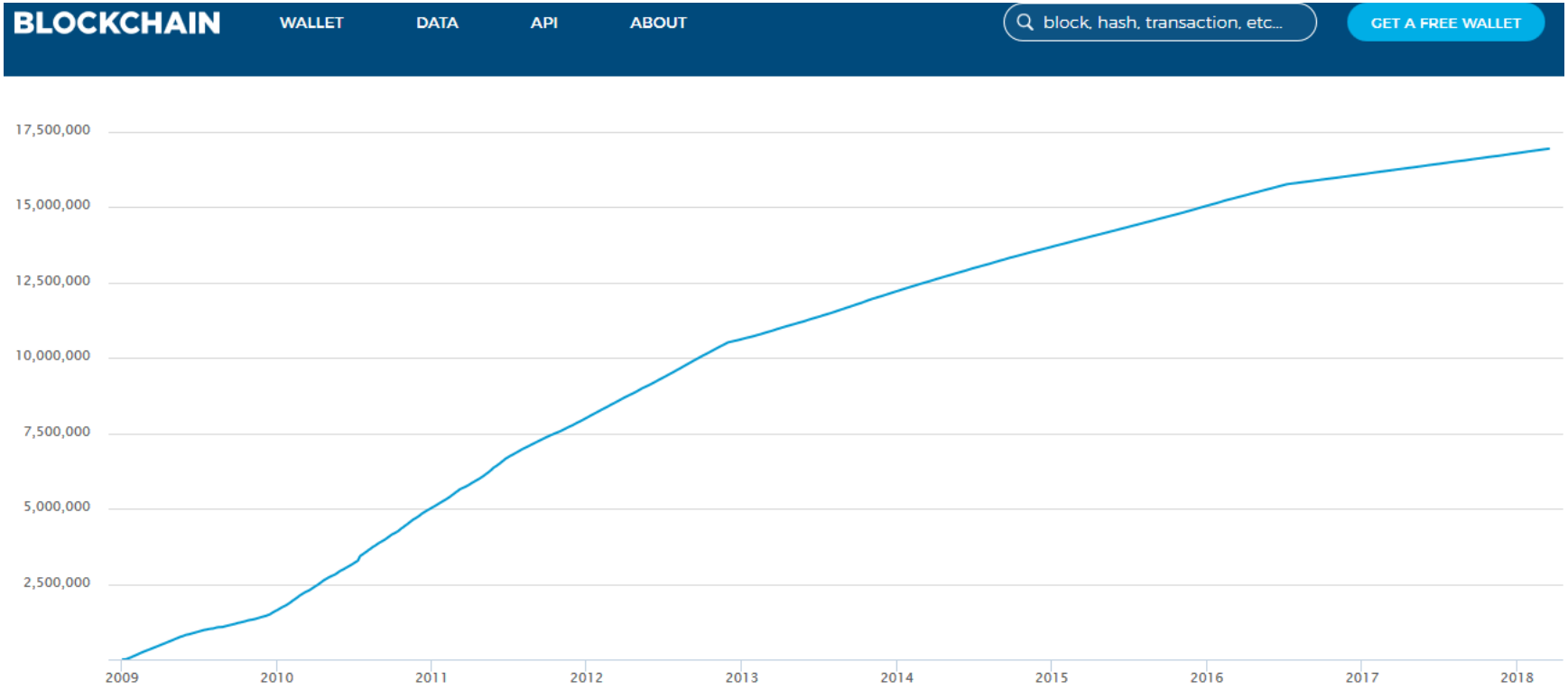
Source: [Bitcoin news]

Venezuelan political uncertainty, command economy, slowly reduces GDP, in particular in the oil sector.

Expected tax revenues fall. Markets think Venezuela will print money to finance government expenditure. Price falls. In fact money printing limited only by paper shortages.

Some Bitcoin facts

- 420 transactions per minute [in the world]
  - 200,000 for Visa alone
- $2000 average size
  - $80 for Visa
- $142bn Bitcoin in circulation
  - $1,200bn paper US currency.
- Bitcoin market share around 55% [by $ value of coinage, Dec 2018].



Bitcoin in circulation. Slowly asymptoting to 21million.

Source: here

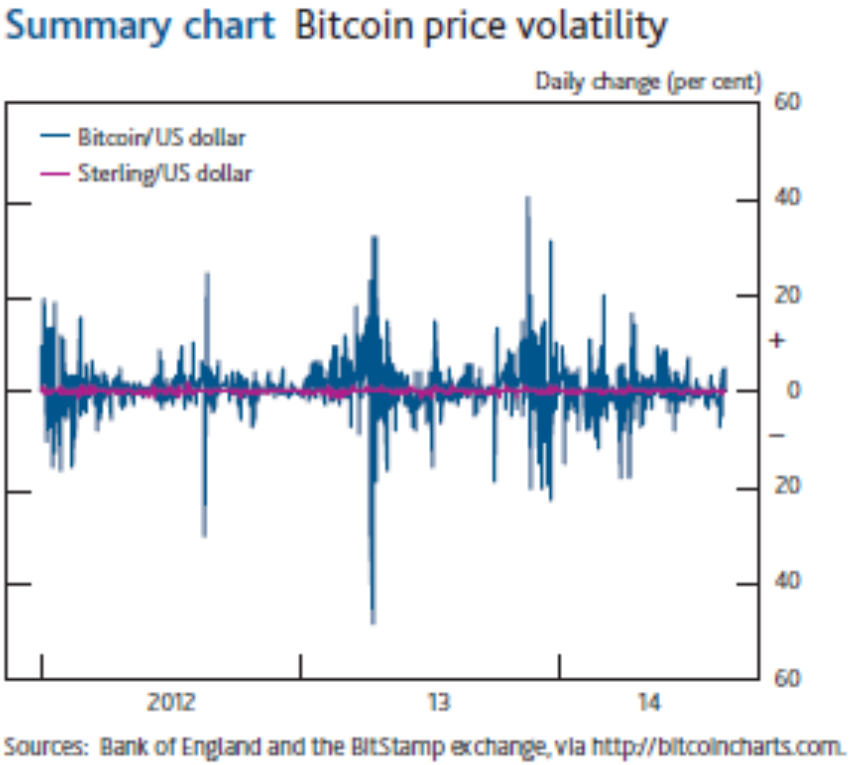
$/Bitcoin exchange rate

Source: Xe

‘Bitcoin=bubble’?

- When people describe Bitcoin as a ‘bubble’, remember:
- All monies, are, in a sense, bubbles, since intrinsic worth ≠≠ exchange rate.
- Tulips in C17th Amsterdam, art, Assignats in C18th France, gold, Yap stones, Cowrie shells, wine, cheese.
- Bubble could reasonably mean difference between intrinsic worth and face value.

Bitcoin price volatility

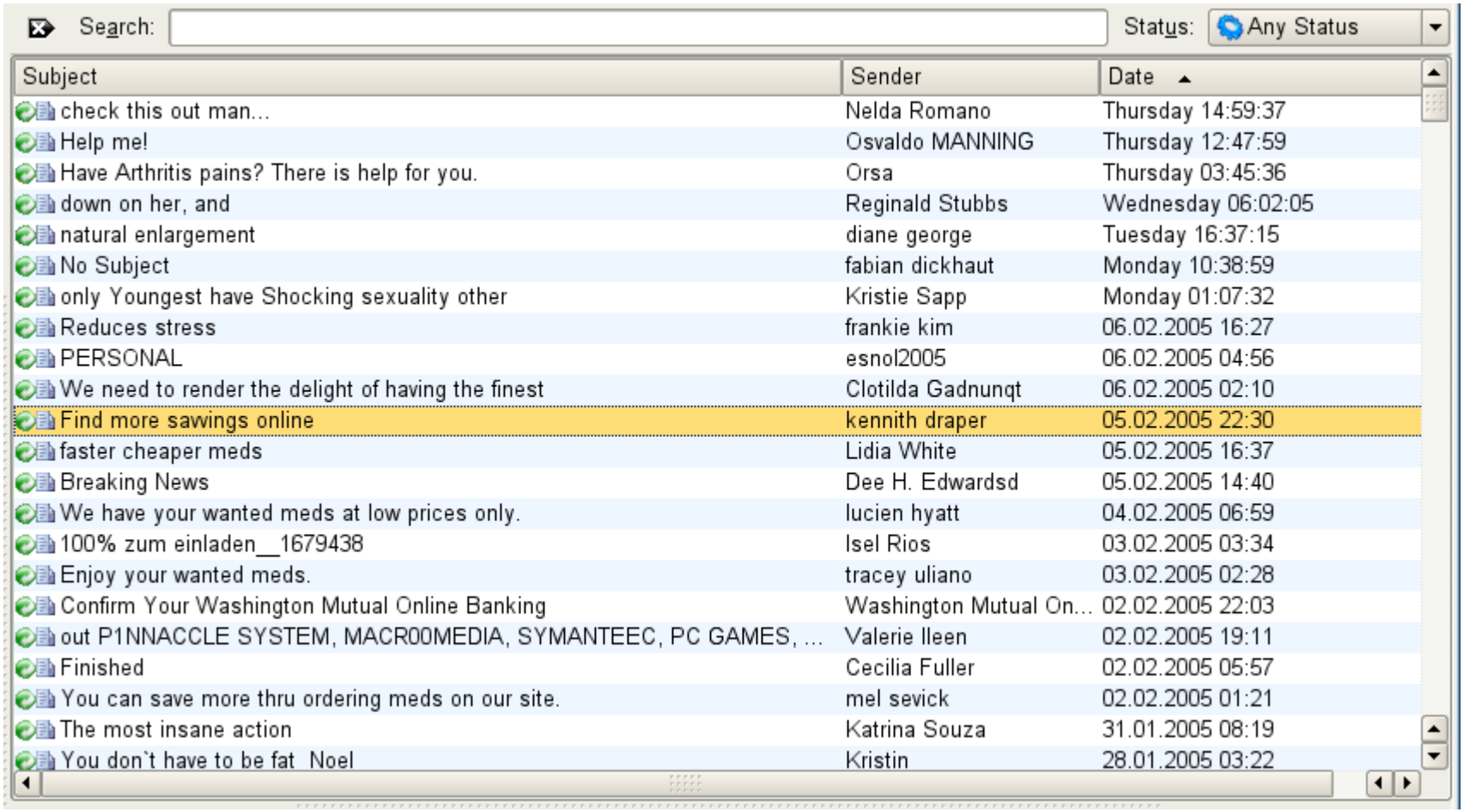


Bitcoin's volatility is qualitatively the same as other currencies, but quantitatively MUCH bigger.

Take over requirements for a new money

- Unit of account [No]
- Medium of exchange [Only beginning]
  - Portable [Yes, much better than money]
  - Divisible [Yes, infinitely so]
- Store of value [Not a good one, yet]
- Inherently worthless [Yes]
- Not resource intensive [Yes and No]
  - Consumes a lot of electricity, but few physical resources to represent it.

Bitcoin, infinite divisibility and spam



Kill spam by insisting that to send an email you have to pay receiver 0.0000000001 Bitcoins

Bitcoin and the distributed ledger

Distributed ledger

- Main innovation is the distributed ledger.
- This resolves the ‘double spend’ problem for an e-currency.
- Physical coin or paper note:
  - If I give a paper note to person A I cannot then give that note to anyone else to spend again.
- Bank deposits as e-money:
  - we trust banks to deduct numbers from column ‘Tony’ in Barclays spreadsheet and add them to column ‘Person A’ in HSBC spreadsheet.

Traditional money ledger

- Centralised, tiered, hierarchical.
- Bank branch has ledger of its account holders.
  - Bank has ledger of its branches, and account holders
    - Central bank has ledger of bank balances

Distributed ledger/ctd…

- Copies on 100's of k's of computers
- Public copies of bitcoin wallets.
- Output of prior agreements by consensus protocol
- 'Blockchain'=chain of 'blocks'; each past block is an agreement to a transaction proposed by a Bitcoin wallet holder.
- Chain of blocks [Blockchain!] gets you from initial endowment to current distribution of Bitcoins.

Some details about the Blockchain

- 1: Tony agrees to buy lecture from Eric for Bt1
- 2: Tony proposes to move Bt1 from Tony's wallet to Eric's wallet
- 3: 'Miners' propose a verification [or not] of the hypothesis that :
  - Tony [actually my electronic pseudonym protected by a private 'key'] is connected with that wallet
  - and has the necessary Bitcoins
  - and that the transfer destination is genuine.
- 4: Other miners will agree with this provided verifying miner has satisfied a 'proof of work' condition.
- Proof of work is proof that you have expended a lot of computing power in some tangential cryptographic/mathematical task.
- Example would be reporting the n'th prime number. Difficult to do, but easy to verify. [Bad example, as prime numbers known, and new ones too difficult to find].

Distributed ledgers

- Many applications, not just e currencies.
- Financial asset ownership: bonds, shares, real estate
- Barter cooperatives [babysitting or DIY services!] and ‘local currencies’.
- Email spam.

DIGITAL CURRENCY AND CENTRAL BANK MONETARY POLICY TARGET/ RULE

Suppose Bitcoin takes over….

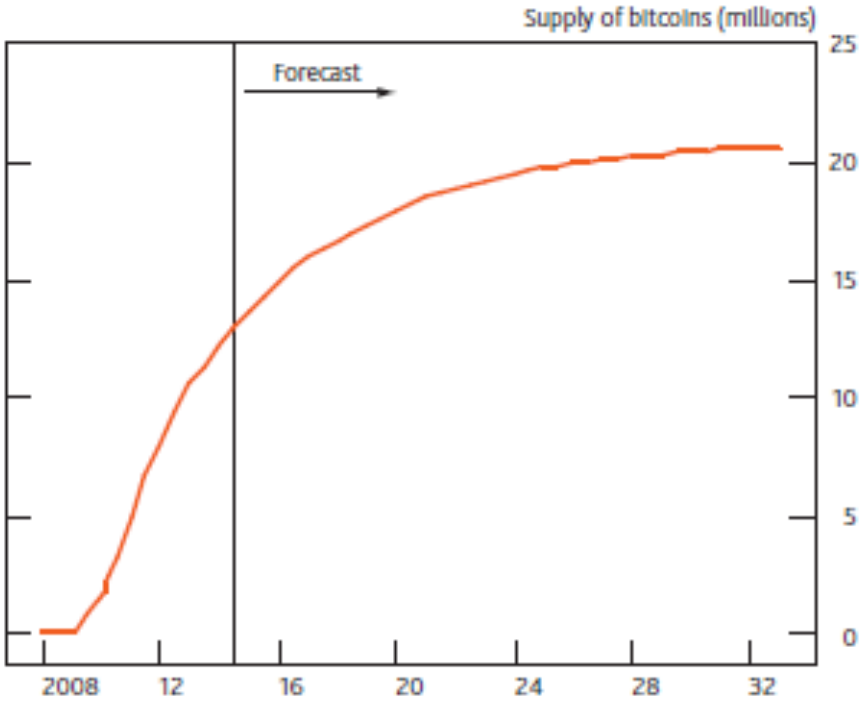
- Bitcoin gains popularity: people substitute out of local or $ fiat currency
- Central banks lose control of monetary policy
- Participants, and even non-participants are subjected to Bitcoin ‘monetary policy’.
- What is Bitcoin monetary policy?

Bitcoin's monetary policy

- Bitcoin has its own monetary policy:
  - Consensus over protocol for rewarding the 'miners' for verifying and voting on the legitimacy of Bitcoin transactions.
  - Implies asymptotic convergence to fixed number of 21 million Bitcoins.

Long run Bitcoin supply

Chart 1 The projected supply of bitcoins in circulation



Source: http://blockchain.info.

Currently agreed protocols for verifying transactions and rewarding the verifiers [‘miners’] means fixed limit.

But this is not inherent in the technology and participants could vote in the future to revise it and devise a new protocol.

Pitfalls of Bitcoin monetary policy: inflexibility of the policy ‘rule’

- Modern cb monetary policy involves flexible response of interest rate / money supply to allow low and stable inflation.
- Bitcoin monetary policy is not entirely fixed, but revisions [to the reward for miners’ verification activity!] likely to be infrequent and not flexibly designed around an inflation target.
- Price-level-like rule likely to deliver periods of inflation and deflation.

Bitcoin's deterministic money supply rule

- For some, anchored money supply is a feature, not a bug.
- Libertarian political economists drawing on traditions of Hayek and Austrian school.
- Private currencies:
  - self-disciplining; compete for market share
  - avoid inefficiency, malfunction, or expropriation by malign state agents like central banks and finance ministries

Non-desirability of deterministic Bitcoin supply rule

- This viewpoint neglects the role of money demand, not just money supply in price level determination.
- Latin American dollarisations: hyper-inflation caused by fall in demand for pesos.
- French Revolution: citizens demand for 'Assignats' fell. Rose only when using commodities became capital offence.

Pitfalls of Bitcoin mon pol: international spillovers

- Bitcoin and similar are borderless.
- Trading area won't constitute an optimal currency area [in sense of Mundell]
- No fiscal transfers or freedom of movement.
- Also, the bad monetary policy there will have spillovers to the non-Bitcoin currency area.

CENTRAL BANK DIGITAL CURRENCY: MOTIVATION AND CONSEQUENCES

CB digital currency

- To prevent a takeover by private sector Bitcoin or similar, cb could offer its own digital money.
- What would a central bank digital currency consist of ?
- Implications for:
  - Monetary policy
  - Financial stability policy and banking
  - Taxation/illegal economic activity

What is a central bank digital currency?

- We already have it:
  - Accounts for banks: electronic central bank 'reserves'
  - Currently UK/US pays interest on these reserves
- Current services are not provided to firms or individuals…
- … but they could be, in response to the 'threat' of currency substitution posed by Bitcoin.

CB digital currency vs Bitcoin

- Would cb digital accounts head off a Bitcoin takeover?
- Centralised ledger, not decentralised.
- Can charge interest flexibly [Bitcoin cash mgt also involves fees currently, but not flexibly adjustable].
- Not inherently anonymous, like cash or Bitcoin
- Lack of anonymity good and bad:
  - Constrains illegal economic activity
  - Leaves gap in the market for anonymous medium of exchange so may not prevent Bitcoin takeover.

CB digital currency and the zero lower bound

- Central bank accounts for firms and households
- Could pay interest, [backed and funded by government securities]
- Could pay negative interest, unlike cash [currently]
- Which would overcome the zero lower bound to central bank nominal interest rates. [Kimball, Buiter, Rogoff: see eg my Bristol MSc reading list on this topic].

Recap on the zero lower bound problem

- CB proposes to offer –'ve rates on a deposit with it to investors [banks, whoever].
- Investor thinks:
  - No thanks, I'll invest my money in zero-interest, default-risk free securities=cash.
  - -'ve rates don't transmit to market rates.
- Lower bound = f (cost of cash management)
- Hence some cbs actually managed to lower rates <0, although not by much.

Digital money and monetary policy

- Losing control to Bitcoin monetary policy highly undesirable.
- Role as a disciplining device for cbs uncertain.
- CB digital currency might eliminate a threat of currency substitution.
- CB digital currency provides an opportunity to overcome the lower bound on interest rates.

CENTRAL BANK DIGITAL CURRENCY AND FINANCIAL STABILITY POLICY/ BANKING

Disintermediation of banks

- CB digital money = digital current accounts at the central bank
- May induce substitution out of retail banks.
- Retail banks then have to fund lending in other ways.
- Substitution might wax and wane with the risk cycle: worse when banks in trouble.
- Gives central bank a better interest rate lever [-ve rates] at expense of a credit cycle amplifier.

Chicago plan by accident

- Crisis caused by banks over-relying on debt as opposed to equity to fund lending.
- When loans [assets] turn bad, need funders who don't have to be paid back [equity holders].
- Expectation by debt/deposit holdes of not being repaid is self-fulfilling as deposit holders run or wholesale lenders don't roll over.

UK, Summer of 2007

Chicago plan by accident

- Extreme solution:
  - ‘narrow banks’ which invest deposits in safe assets like government securities
  - No need for private individual or state deposit insurance as narrow banks are self-insuring.
  - Lending undertaken by other institutions that raise equity finance.
  - 1933: Chicago economists inc Fisher, Henry Simons circulate memorandum proposing this.

CB digital money=Chicago plan by accident

- CB becomes a ‘narrow bank’ offering deposit accounts backed by its own balance sheet [government securities] and, implicitly, the government’s.
- Private banks have to find other sources of funds for lending.
- No more bank runs / moral hazard, but:
- Lose some of what makes banks ‘special’, eg: Deposit taking / monitoring role provides information about credit worthiness.

Spillovers from unilateral country central bank digital money

- If say BoE went ahead on its own…
- Could disintermediate foreign banks.
- Foreigners put money in UK central bank, or in an entity – incorporated in the UK - whose main asset is such a deposit.

DIGITAL MONEY AS A WAY TO KILL ILLEGAL CASH-FACILITATED ACTIVITY

- Informal/illegal activity facilitated by cash, particularly large denominations
- Larger the denomination, the cheaper/safer it is to manage balances and carry out transactions.
- Many economies have large ‘informal’ sectors.
  - Otherwise legal activity followed by tax evasion
  - Illegal activity – arms sales, drugs, people trafficking, sex, piracy, sale of stolen goods

Study	Year of study	Estimation Method	Estimation Year/Period	Estimation Country/Region	Estimate[1] (% of GDP or GNP)
Gutmann	1977	Currency Ratio	1976	USA	9.4% (GNP)
Feige	1980	Transactions Method	1976-78	USA	13.2% - 33.1% (GNP)
Dilnot & Morris	1981	Household Income/ Expenditure	1977	UK	2.3%-3.0% (GNP)
Tanzi	1983	Currency Ratio	1930-80	USA	0.6% - 6.1%[2] (GNP) 1.7% - 4.5%[3] (GNP)
Frey & Weck-Hanneman	1984	MIMIC Model	1978	OECD Countries	8.7%[4] (GNP)
Contini	1989[5]	Labour Market	1977	Italy	7.5% (GNP)
Pissarides & Weber	1989	Consumer Expenditure (single equation)	1982	UK	5.5% (GDP)
Bhattacharrya	1990	Currrency Demand	1960-84	UK	3.8%-11.1% (GNP)
Loayza	1996	MIMIC Model	1993	Latin America	38.8%[6] (GDP)
Johnson *et al*	1997	Electricity Consumption	1989-95	Former Soviet Union Former Eastern Europe	12.0%-36.2%[7] (GDP) 16.6%-21.3%[8] (GDP)
Giles	1999	MIMIC Model	1968-94	New Zealand	6.8%-11.3% (GDP)
Lyssiotou *et al*	2004	Consumer Expenditure (demand system)	1993	UK	10.6% (GDP)
Chaudhuri *et al*	2006	MIMIC Model	1994/95	Selected Asian Countries	25.6%[9] (GDP)

Some estimates of the size of the black economy in different coutries.

These are pretty big!

Be wary: how do we estimate the size of a bit of the economy that tries to hide itself from the view of the authorities?

Indian demonetization

- Sudden announcement of withdrawal of 500,1000 rupee notes. [1000R=$15US]
- Large monetary contraction: 85% of note issue to be replaced.
- Designed to confiscate illegally obtained money, and impede future illegal activity.
- Much legitimate activity caught.
- Has to be repeated periodically.
- Central bank digital money is the logical endpoint – total ‘demonetization’ – of this policy.

Sudden demonetization=chaos

Conclusions / recap

- Digital currencies like Bitcoin still small.
- Many problems inhibiting their spread:
  - Volatile prices
  - Fraud and incompetence in exchanges
  - Disagreement in the consensus based community devising the protocols.
- If it did spread, this would have bad effects for the users, and spillovers for the non-users.
- A cb digital currency might prevent this happening.
- It could help overcome the zero bound to interest rates.
- It's the logical endpoint of efforts to demonetize large notes to fight crime.
- But that would have implications for financial stability policy.
- Even for those countries who didn't provide their own digital currency.

Digital currency and your essay question

- How would a financial crisis play out if we had had Bitcoin as our currency rather than central bank fiat currency?
- We would have had an inflexible money supply, so the burden of countering the recession would have fallen much more on fiscal policy, meaning perhaps a much weaker overall response.

Digital currency and the essay question

- Given existing state of banks, LOLR policy would have to be done by issuing bonds and using proceeds to inject equity.
- Credible threat to be able to issue your own currency to bail out the banks not there.
- Not necessarily a bad thing, as currently BoE would not like people to think monetary policy aims compromised by financial stability concerns.

- Have to ask ourselves whether banks would exist in current form. Would they grow without state backing?
- Also would confidence in Bitcoin survive a financial crisis, or would its value fall?

MISC OTHER ISSUES IN CRYPTOCURRENCY WORLD

Uniting the distributed ledgers

- Hundreds of crypto-currencies co-exist. Perhaps competition thwarts the network effect that might precipitate widespread adoption and reaping of main benefits [and also the main costs].
- A distributed ledger for exchanging different crypto-currencies?
- =A distributed ledger for distributed ledgers.

Distributed ledger / Bitcoin governance

- Centralised control or formalised constitution for distributed ledger operations and protocol
- Would solve some of the logjams and problems.
- But it goes against spirit of self-management and decentralised operation.

Transaction speed

- Many Bitcoin miners in China, where local infrastructure not great, and outward bandwidth restricted [as part of internet censorship].
- Speed = f(block ‘size’); number of transactions that can be resolved in each block=f(block size). Fractious discussions ongoing about increasing the block size.