

The Macroeconomics of Digital Currencies in Broad Brushstrokes

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Workshop: Cryptocurrencies in a Digital Economy

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What is the digital economy?

- Fundamental *economic* question: The allocation of scarce (appropriable, non-abundant, non-rivalrous) resources
- The *digital economy* - the use of digitalization and related technologies – is fundamentally changing that allocation:
 - *Economic decision making*
 - *Networks and marketplaces*
 - *Productivity and value added*
- Cryptocurrencies affect all three areas, but especially the second, because it has the potential to revolutionize the institution we call money

Research issues

- What is money and is cryptocurrency really money?
- How will the introduction of cryptocurrencies disrupt financial institutions and the system of payments?
- How will cryptocurrencies change monetary and financial stability?
- What is the role of *central banks* in such a world? Will they crowd out private cryptos or will they be crowded out?

Money: What is it?

- *Groucho Marx (1890-1977):*
“Money frees you from doing things you dislike. Since I dislike doing nearly everything, money is handy.”



Money: What is it?

- *David Hume (1752):*

"Money is not, properly speaking, one of the subjects of commerce, but only the instrument which men have agreed upon to facilitate exchange of one commodity for another. It is none of the wheels of trade: It is the **oil** which renders the motion of the wheels more smooth and easy. If we consider any one kingdom by itself, it is evident that the greater or less plenty of money is of no consequence."

David Hume, "Of Money", 1752, reprinted in *Essays: Moral, political and literary*, 1754, p.281)



Money: What is it?

- *William Stanley Jevons (1835-1882):*
described money as:

1) Medium of exchange

2) Unit of account

3) Store of value: a technology for transferring resources from the present into the future

4) Standard of deferred payment



Money: What is it?

- *Ultimately* it is an asset generally accepted as such by others
- *Other, less conventional definitions:*
 - An asset with a high convenience yield (Friedman)
 - An anonymous system of record-keeping and transactions verification (Kocherlakota 1996)
 - A bubble to eliminate dynamic inefficiency (Tirole 1985, Weil 1987)
 - A vehicle for capital flight / criminal activity / tax evasion
- Are cryptos money? Can they replace bank liabilities? Maybe monetary theory can inform this judgment.

What does monetary theory say?

- *The Cambridge equation. $MV=PY$* (Marshall, Pigou)
- *Dynamic models of money demand.* Cagan (1956)
- *Overlapping generations models (OLG).* Samuelson (1958), Sargent and Wallace (1975)
- *Growth models with money.* Tobin (1965), Sidrauski (1967)
- *Turnpike model.* Townsend (1980)
- *Cash-in-Advance, Money-in-Utility-Function.* Clower (1967), Feenstra (1986), Lucas (1982)
- *Transactions costs/liquidity services.* Schmitt-Grohé, Uribe (2004)
- *Monetary models with search.* Lagos/Wright (2005)

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Cagan Model (Cagan, 1956)

- Logarithm of the traditional money demand function:

$$m_t - p_t = y_t - \eta i_t$$

where small letters denote natural logarithms (except i)

- By the Fisher relation, the *nominal* interest rate i is:

$$i_t = r_t + \pi_t^e = r + \Delta P^e_{t+1}/P_t \approx r + p^e_{t+1} - p_t$$

where r is the real interest rate. Let $r \approx 0$. Then write

$$m_t - p_t = y_t - \eta(p^e_{t+1} - p_t)$$

as a forward looking first-difference equation

$$p_t = (1 + \eta)^{-1}(m_t - y_t) + (1 + \eta)^{-1} \eta p^e_{t+1}$$

Cagan Model (Cagan, 1956)

- ...which has solutions of the following form:

$$p_t = \frac{1}{1+\eta} \sum_{i=0}^{\infty} \left(\frac{\eta}{1+\eta} \right)^i (m_{t+i}^e - y_{t+i}^e) + \kappa \left(\frac{1+\eta}{\eta} \right)^t$$

- First term is the **fundamental component** of price. Depends on expected abundance of present and future liquidity services relative to the demand.
- Second term is the **bubble** or **non-fundamental component** which need only continue to grow at a steady rate. κ could be *stochastic* w/ expected value 0.
- Rational expectations places restrictions on variance.

Cagan Model (Cagan, 1956)

- The first key lesson of the Cagan model: monetary collapse is driven by *expectations of future prices*
- But what *causes* these expectations? Are they rational?
- In standard models, the underlying problem is central bank finance of government budgets
- With private cryptocurrencies this is cannot be an issue because supply is algorithmic, predetermined
- ...but the bubble is all the more relevant!

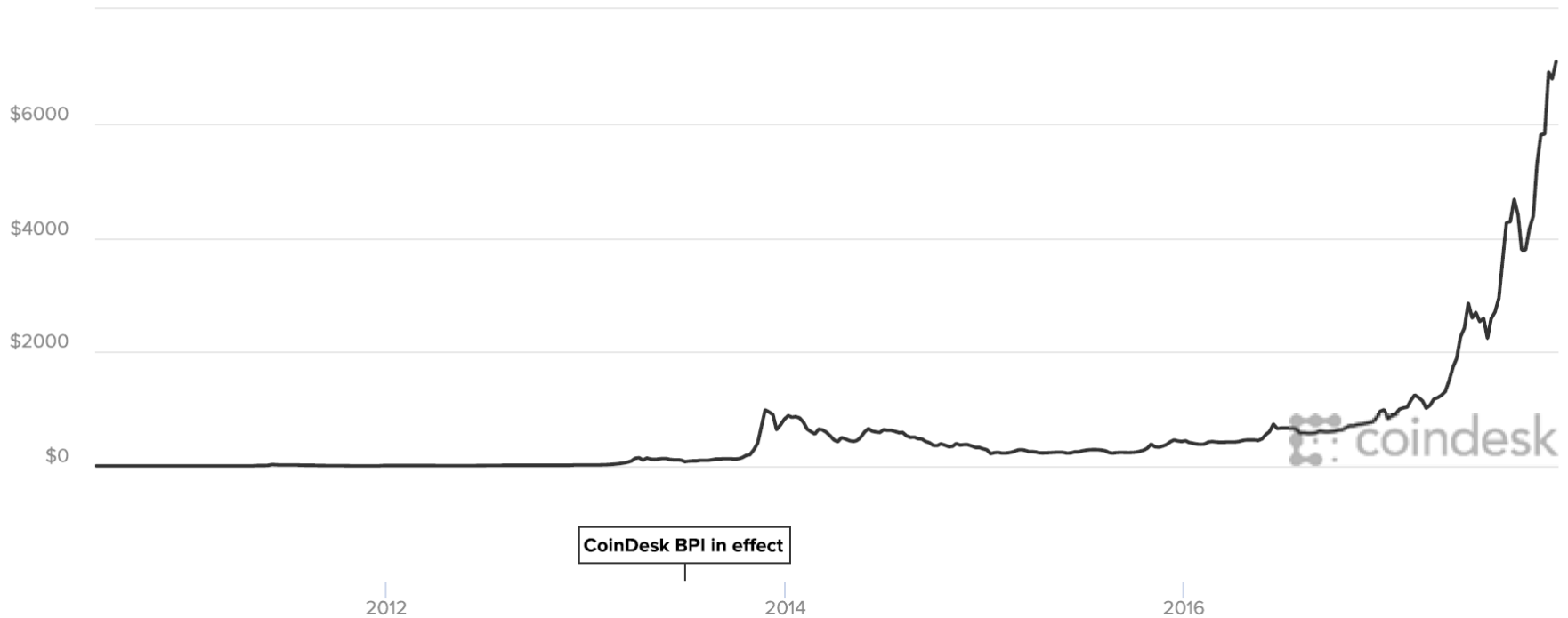
Bitcoin (USD) Price

Jul 18, 2010

to

Nov 16, 2017

Export



\$7,923.48 ▲ 8.85%

Today's Open	\$7,279.00	Change	▲ \$644.48
Today's High	\$7,983.72	Market Cap	\$0.132T
Today's Low	\$7,122.46	Supply	16,683,438

Tulipmania, Jan-Feb 1637



Box 19.5 Tulipmania⁹

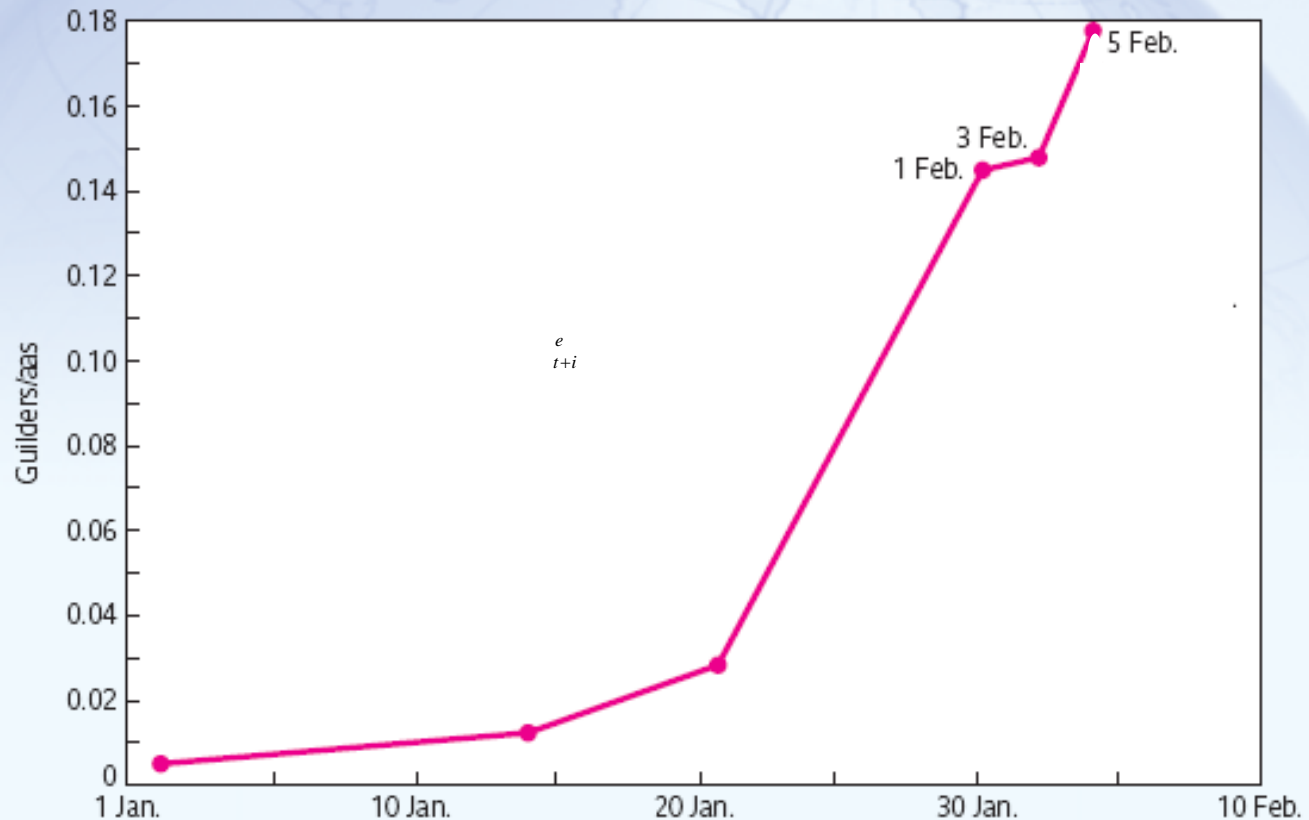


Fig. 19.8 Tulipmania, 1637

History has given us several instances of price behaviour that looks like speculative bubbles. In Holland, the price of rare tulip bulbs during the seventeenth century rose by extraordinary rates within a month's time, only to collapse thereafter.

Source: Garber (1990).

The NASDAQ Bubble, 1996-2001

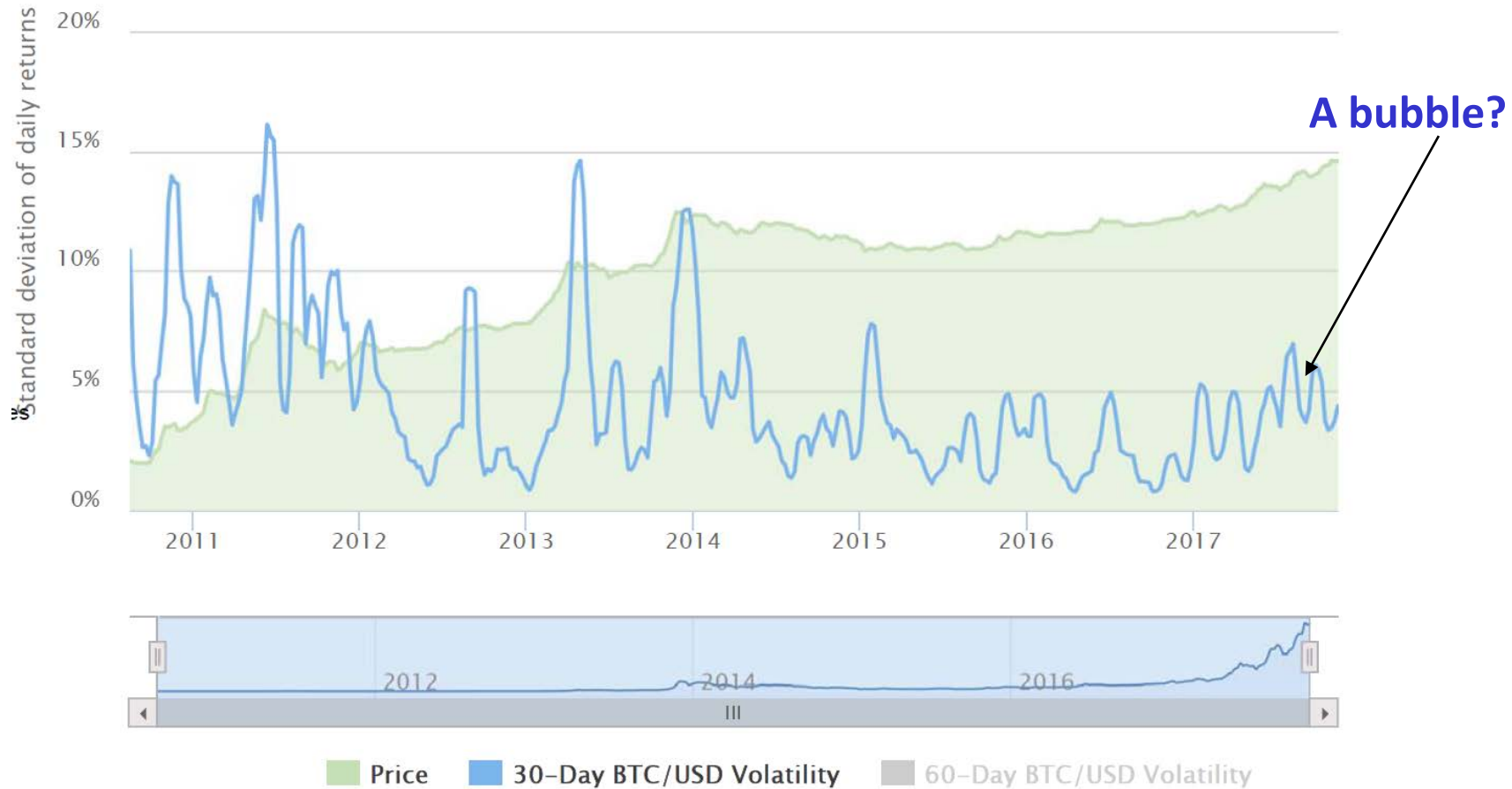


Source: <http://www.bigcharts.com>

Oil price (Brent, \$/barrel) 2000-2009



BCN Volatility 30-day moving avg. (2011-2017)



Source: www.buybitcoinworldwide.com

Are crypto-currencies *really* money?

- *Not* a means of payment: \$200b “market cap” on a world money supply of >\$80tn (\$100tn on PPP basis) \approx **0.5% of the world money supply** (of which 90% is from banks)
- Technical feasibility of true medium of exchange function
 - BCN: 10 tps BCN
 - Visa: 2000 tps, 50-60 Transactions per second peak
- *Not* yet a unit of account
- *They are* a store of value (“asset class”), but *not* very reliable, and don’t pay interest (yet)
- They rely on proof of work, not proof of ownership
- THAT is the inherent advantage of the central bank. A central bank has trust! Why reinvent the wheel?

Monetary stability

How do they change monetary stability?

- On the one hand, widespread use of cryptocurrencies for conventional transactions decreases the risk of financial crises
- On the other hand, the co-existence of banks that conduct commercial transactions may increase overall systemic risk:
 - Commercial bank credit risk
 - CME futures, options contracts
 - Internet risk, programming risk, geopolitics of proof-of-work
 - Loss of control
 - Fluctuating Altcoin-currency exchange rate

Central banks

What is the role of *central banks* in such a world?

- For the past 400 years, central banks have been a source of trust in a mistrustful and untrustworthy world
- Central banks' economic advantage: Efficiency in creating trust as a public good
- Cryptocurrency's disadvantage: The technical difficulties of massive transaction validations are yet unsolved. Some centralization is advantageous
- Is a solution a web of competitive large blockchains?

Commercial banks

What is the role of *commercial banks* in such a world?

- For the past 250 years, commercial banks clearing have provided the leading transaction technology (tiered ledgers).
- Is a solution a web of competitive large blockchains?
Will banks be crowded out?
- “Glass-Steagall through the back door”

Conclusion

- Money is a lot of things for lots of different people (Jevons). But are are cryptocurrencies:
 - a medium of exchange? NO
 - unit of account? NO
 - a store of value? Yes
 - a standard of deferred payment? NO
 - a bubble outlet? YES
 - a favorite vehicle for capital flight? YES ++
 - a source of financial instability? WE SHALL SEE

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Kumhof

- Interest payments for CBDC ! It's the Sargent-Wallace point
- Puts government money back into the model
 - Different from reserves
 - Pays interest
 - Competes with deposits
- Sidrauski (1967) Model !
- Deposits at the stroke of a pen – a jumping variable !!!
- Shortage of the “circulating medium” – need to issue scrip]
- CBDC is like government debt! (Chicago plan)

Kumhof

- In his model he has a lower rate on the CBDC
- Target aggregate or interest rates
- Shock: total liquidity shock – banks supply at the margin
- Bank runs?

Florian Tschorsch

- Technical feasibility (Florian Tschorsch)
 - 10 tps
 - 2000 tps Visa 50-60 Transactions per second peak
 - p2p Payment *channels* (Scalability) + time lock + smart contracts off chain (how often are they settled) for a few days
 - Payment channel *networks* single versus multiple path routing as a flow algorithm
 - push.relabel algorithm uses local knowledge push to neighbor of smaller height otherwise increase node height (fluid flow model)
 - Multipath route selection
 - Sequential execution requires coordination
 - Bitcoin as a settlement network

Risiken und Nebenwirkungen

- Max said:
 - Segregated Witness?
 - Forks
 - Bitcoin Gold
 - Wallet risk ! Crazy
 - Bubble + financial crisis risk – contact with the banking sector is growing

Definition

- A blockchain is a system of record sitting right on the transaction, the truth in between
- “In a perfect classical economy there will be no contract disputes”