Cryptocurrency Stabilization

UCL Cryptocurrency Seminar

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Coin Supply and Volatility

Design Goal and Two Hard Problems

Solution to Problem 1: Seigniorage Shares

Solutions to Problem 2

Alternative Approach: SchellingDollar

Outline

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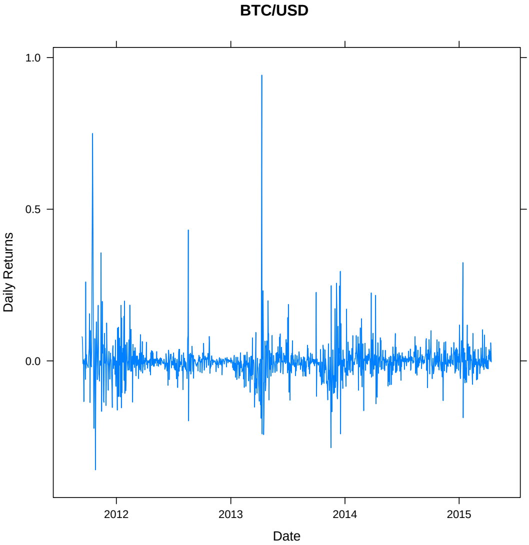
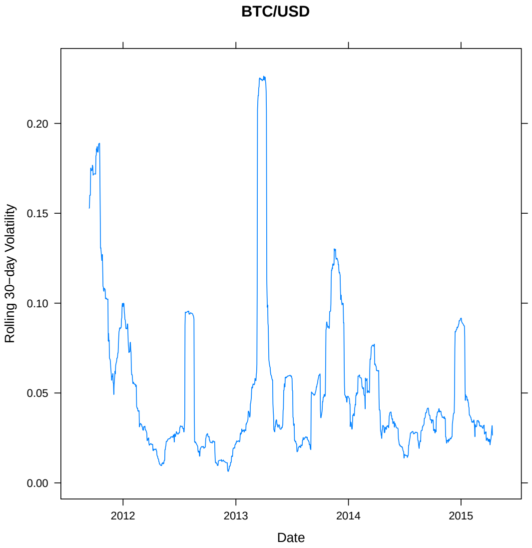
Bitcoin Volatility



Do you see a trend?



Will Bitcoin Volatility Decline?

Short answer No.

Longer answer No, unless future demand becomes more predictable.

And, no, a more liquid BTC market will not make Bitcoin's price more stable. . .

The main volatility in bitcoin comes from variability in speculation, which in turn is due to the genuine uncertainty about its future. More efficient liquidity mechanisms don't help reduce genuine uncertainty.
Nick Szabo

Deterministic Coin Supply

What is “deterministic coin supply”?

The growth rate of coin supply is completely specified in advance and is not influenced by facts outside of the system.

- This is *not* "digital gold"
- Even gold has a supply that responds to its price
- Bitcoin is more like a "digital collectable"

Coin Demand

Transactional Coin Demand CD_T Desire to hold a certain quantity of coins for the purpose of making transactions.

Speculative Coin Demand CD_S Desire to hold a certain quantitiy of coins to speculate on future increases in coin price / purchasing power.

Coin demand made up of both transactional and speculative motives

$$CD = CD_T + CD_S$$

Coin Demand

Coin demand is a quantity of purchasing power

$$CD = P \times Q$$

- P purchasing power, coin price of a broad basket of goods and services
- Q quantity of coins demanded given P

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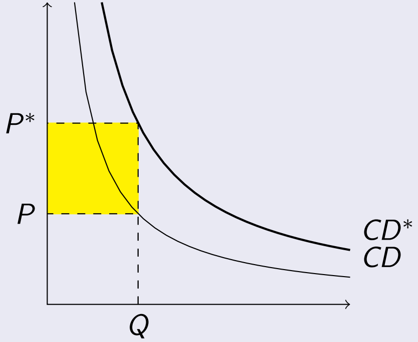
Coin Demand Curve (and fixed supply)

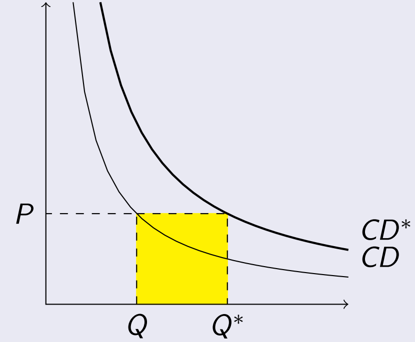
CD Change with Fixed Supply



With a deterministic supply protocol like Bitcoin's, an X% increase in **demand** (CD to CD^*) causes an X% increase in **coin price** (P to P^*) because supply is fixed in the period.

Coin Demand Curve (fully elastic supply)

CD Change with Elastic Supply



An X% increase in **demand** (CD to CD^*) causes an X% increase in **coin quantity** (Q to Q^*) because supply can change in the period.

Deterministic Supply Causes Volatility

- If demand growth exceeds pre-programmed supply growth, coin price will increase.
- But if we **expect today** that this will happen in future, then price increase will happen today (**"Law of Iterated Expectations"**).
- Therefore, bitcoin price reflects today's expectations of future demand growth.
- ... and deterministic supply **creates speculative demand** CD_S.

A prediction market on itself

So bitcoin price is a like a prediction market on the growth rate of its own future adoption. Price volatility reflects irreducible uncertainty about its future.

“So it’s like a growth stock, right?”

Transactional coin demand CD_T is inversely related to coin volatility.

The more volatile the coin, the less useful it is as a medium of exchange.

- Volatility raises **transaction costs** for merchants.
- Volatility renders coin useless as a **unit-of-account**.
- Volatility increases need for **re-balancing**.

No, it’s not like a growth stock

The stock price of a young, high growth company is also volatile. But the volatility of the a growth company’s stock **does *not* influence the demand for its product**. But the volatility of bitcoin *does* influence the demand for bitcoin as a medium-of-exchange.

Elastic Coin Supply

Core Operational Principle

At the end of some pre-defined interval of time (the *rebase period*, every n blocks), if the change in coin price of the interval is X%, change coin supply by X%.

$$\begin{aligned} Q_i &= Q_{i-1} \times \frac{P_i}{P_{i-1}} \\ \Delta_i &= Q_i - Q_{i-1} \end{aligned}$$

, where i is the i-th rebase period, Q is coin supply and P is coin price.

Theoretical Lineage

Bitcoin

- Gold standard
- Austrian Economics

Stablecoin

- Milton Friedman's "k-percent rule"
- Irving Fisher's "Dollar Stabilisation"

- Both favour "rules over discretion" w.r.t. money supply.
- These theories assume fractional reserve banking.
- Differing opinions about nature of money demand.
- Ironically, Bitcoin gives rise to very "Keynsian-like" money demand.

Two Hard Problems

1. **Coin distribution**. How is Δ_i distributed?
2. **Data representation**. How can P_i be represented inside the network in a way that requires minimal trust?

Solution Attempt: Hayek Money

Pro-rata Rule

Distribute Δ_i pro-rata over wallet balances: multiply each wallet balance by Q_i / Q_{i-1}.

Why it doesn't work

Hayek Money only stabilises **coin price**, it doesn't stabilise coin **purchasing power**

Ferdinando Amertrano, *Hayek Money: The Cryptocurrency Price Stability Solution*
`http://ssrn.com/abstract=2425270`

Solution Attempt: Hayek Money

The Three Functions of Money

1. Unit-of-Account (UoA)
2. Store-of-Value (SoV)
3. Medium-of-Exchange (MoE)

- Price stability must stabilise both UoA and SoV. Hayek Money only stabilises UoA.
- trades a **fixed wallet balance with fluctuating coin price** for a **fixed coin price with fluctuating wallet balance**.
- purchasing power of a Hayek Money wallet is just as volatile as a Bitcoin wallet balance.
- Self-defeating dynamic of CD_S driving out CD_T remains.

Solution Attempt: Inv/Sav Wallets

Distribute over Inv Wallets

Allow users to divide coin balance between "Investment" (Inv) and "Savings" (Sav) wallets. Distribute Δ_i over Inv wallets.

- Solution appreciates that there must be two different vehicles for two different sources of coin demand: Sav Wallets for CD_T and Inv wallets for CD_S.
- Δ_i should apply to the CD_S vehicle (Inv wallets)

Massimo Morini, *Inv/Sav Wallets and the Role of Financial Intermediaries in a Digital Currency*
`http://ssrn.com/abstract=2458890`

Solution Attempt: Inv/Sav Wallets

Why it doesn't work

1:1 convertibility between Inv and Sav wallets means that no incentive at time t to keep coin in Inv wallet when expectation is that $\Delta_{t+1} < 0$.

We need *two* coins

- coins and shares
- **coins** are the object of stabilisation
- Δ_i is distributed over **shares**
- coins and shares exchange at a ***market*** rate
- **shares** can be valued

Creation of One Requires Distruction of the Other

$\Delta_i > 1$: coin supply needs to *increase*

- Auction at end of rebase period **buying** Δ_i *worth of shares*; users can **offer shares**.
- Δ_i worth of shares are bought at winning coins-for-shares price P^S.
- Δ_i coins are **created**.
- Δ_i worth of shares are **destroyed**.

Creation of One Requires Distruction of the Other

$\Delta_i < 1$: coin supply needs to *decrease*

- Auction at end of rebase period **selling** Δ_i *worth of shares*, users can **bid for shares**.
- Δ_i worth of shares are sold at winning coins-for-shares price P^S.
- Δ_i coins are **destroyed**.
- Δ_i worth of shares are **created**.

How do we value shares?

Problem

So if long-term growth rate of Δ_i is positive (demand for coin on average grows), then shares become increasingly scarce. How can we value those shares?

Solution

Consider the following shares investment strategy where you own ω shares.

- When $\Delta_i > 1$, **buy** $|\frac{\Delta_i}{P_i^s Q_i^s}| \times \omega$ shares in the auction.
- When $\Delta_i < 1$, **sell** $|\frac{\Delta_i}{P_i^s Q_i^s}| \times \omega$ shares in the auction.

What has this strategy done?

Share owner maintains a position that is a **constant percentage** of the outstanding share supply. Therefore, his investment is a claim on a constant percentage of $\Delta_i, \Delta_{i+1}, \Delta_{i+2}, \ldots$ coin-denominated **cash flows**.

Valuation is a simple Net Present Value (NPV)!!!

Fair Value of Shares

$$P_t^s = \frac{1}{Q_t^s} \sum_{i=t}^{\infty} \frac{\Delta_i}{(1 + r_i)^i}$$

Shares are like equity, where the income is coin seigniorage. Hence the name ***Seigniorage Shares***.

The Monetary Yin-Yang

Coins Call them ***Yin***. Caters to CD_T, . . . stable, feminine, risk-averse.

Shares Call them ***Yang***. Caters to CD_S, . . . volatile, masculine, risk-taking.

- Stable coins need shares to absorbe periods of declining coin demand, to assume the risk of unpredictable changes in money demand.
- Shares need stable coins to generate demand growth in the first place.
- So CD_T and CD_S reinforce each other under the monetary yin-yang of seigniorage shares, but undermine each other under the "barbarous relic" of fixed coin supply (eg Bitcoin).

Problems and Questions

- What happens when CD growth rate slows and ratio of shares market value to coin market value goes from > 1 to < 1?
- Is it possible for coin to devalue in an orderly way?
- Any market manipulation vectors implicit in auction design?

Strategies for Modelling Coin Value

Exogenous Solutions

- Trusted oracles
  - "but I thought cryptocurrency was supposed to be autonomous of any trusted third-parties"
- Schelling games
  - is truth really a Schelling point?

Endogenous Solutions

- Transaction volume
  - assumes stable money velocity
  - subject to manipulation
- **Difficulty-based estimators**
  - Promising strategy! See estimator research by Vitalik Buterin `https://github.com/ethereum/economic-modeling/tree/master/stability`

Restricting Schelling Game to Shareholders

- What if only shareholders could play the Shelling game, perhaps pro-rata their percentage of share ownership? Does
- We can prove that shareholders do not have an incentive w.r.t. their shareholdings to submit dishonest coin valuations. Exaggerating the supply of coin that needs to increase does increase NPV of share price in coin-denominated terms, but no effect on real share price.
- Arguably, expectations of real coin demand will decline with dishonest coin valuations, so shareholders have an incentive w.r.t. share wealth to vote the truth.

Restricting Schelling Game to Shareholders

This was done late at night

...so the following may contain errors!!

Simplify the set-up a bit (hopefully, without loss of generality) and say that the expected demand growth for coin is g, so

$$\Delta_t = \Delta_{t-1}(1+g) \tag{1}$$

, where $g < r$ and the valuation model from previous slide can be defined in terms of g and r:

$$P_t^s = \frac{1}{Q_t^s}\sum_{i=t}^{\infty}\frac{\Delta_i}{(1+r_i)^i} \tag{2}$$

$$= \frac{1}{Q_t^s}\frac{\Delta_t}{r-g} \tag{3}$$

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Restricting Schelling Game to Shareholders

Question

If shareholders had the power to represent coin price P_i to the network, do they have an incentive to be untruthful w.r.t. their share wealth?

- Let ρ_i be the true market value of the coin index and let $\epsilon = P_i/\rho_i$ be the measure of untruthfullness.
- It might be argued shareholders have incentive to make ϵ large, exagerate value of coin in order to squeeze more seigniorage out of system.

Restricting Schelling Game to Shareholders

Implication for coin price

If we hold CD constant, then a non-zero ϵ will cause the actual coin value $\hat{P}_t$ to change to:

$$\hat{P}_t = P_t \frac{1}{\epsilon} \tag{4}$$

Implication for share price

$$\hat{P}^s_t = P^s_t \epsilon \tag{5}$$

Vitalik Buterin's SchellingDollar Model

- Two currencies, *vol-coins* (V) and *stable-coins* (S)
- Can only hold 0 or positive balance of V
- Can hold negative or postive balance of S. But negative balance of S requires quantity of V equal in value to 2X their new S balance.

Example

If S is \$1 and V is \$5, then if user has 10V (\$50) they can at most reduce their S balance to -25.

- If value of user's negative S exceeds 90% of the value of user's V, then user's S and V balances are both reduced to zero. (implication for total V supply)

Vitalik Buterin's SchellingDollar Model

- Can convert between S and V at a rate of \$1 worth of V per S, plus a small exchange fee (implication for total V supply)
- System keeps track of total +S and -S in circulation.
- If $\frac{+S}{-S} > 1$, system imposes a negative interest rate on all V to make +S holdings less attractive and -S holdings more attractive.
- If $\frac{+S}{-S} < 1$, system imposes a positive interest rate on all V to make -S holdings less attractive and +S holdings more attractive.

How Do We Value V in SchellingDollar Model?

- As with Seigniorage shares, all changes in +S demand are V's "income".
- V profits from TX fees for exchanging V and S.

Additional Profit/Loss for V

- increase in V price and $\frac{+S}{-S} > 1 \rightarrow$ decrease V supply
- decrease in V price and $\frac{+S}{-S} > 1 \rightarrow$ increase V supply
- increase in V price and $\frac{+S}{-S} < 1 \rightarrow$ increase V supply
- decrease in V price and $\frac{+S}{-S} < 1 \rightarrow$ decrease V supply

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Some Problems/Questions with SchellingDollar

- Pro-cyclical interest rate... what implications does this have for expectations of long-term +S demand growth?
- Negative correlation between V price changes and $\frac{+S}{-S}$.

Correlation Drag?

If correlation between V price changes and $\frac{+S}{-S}$ is negative, then this acts as a tax on V... lowers its fair value. Reasons why correlation might be negative:

- Rebalancing...-S holders must buy V when price goes up and sell V when price goes down to keep leverage ratio constant.
- Serial correlation in V price. Reasonable to predict demand for leveraged V positions higher in a bull market than in a bear market.

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