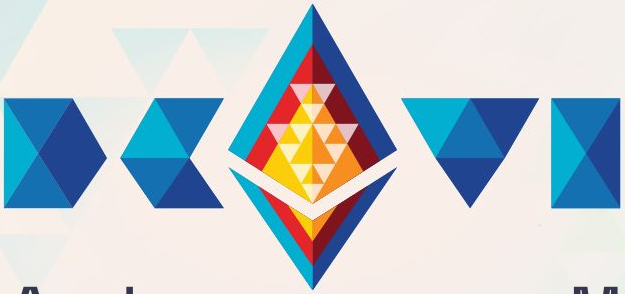


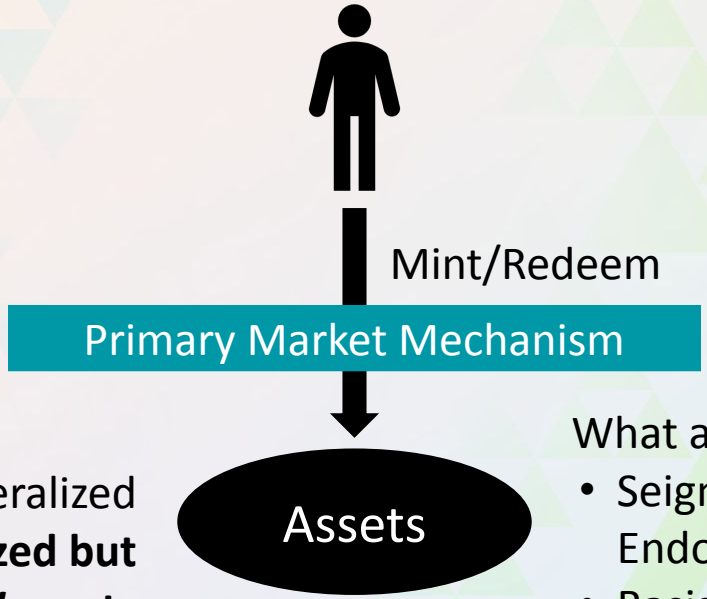
Designing Autonomous Markets for Stablecoin Monetary Policy

Steffen Schuldenzucker, Ariah Klages-Mundt

Superluminal Labs

GYROSCOPE

A Simple Primary Market Model



Normal times: ≥ 100% collateralized

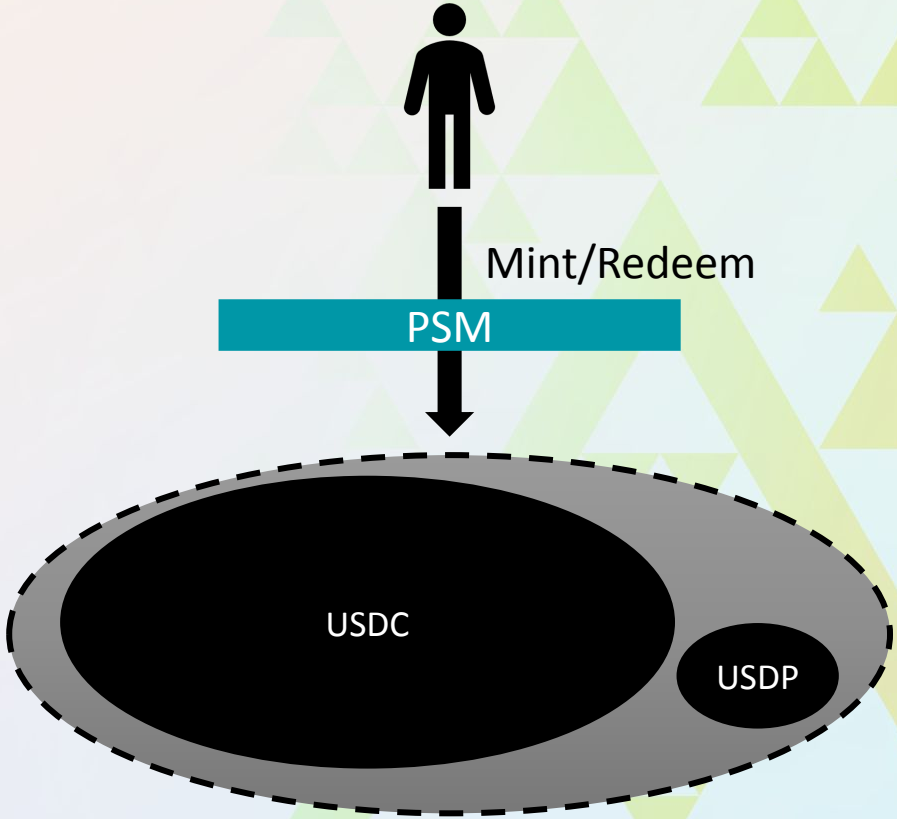
Possibly: ≥ 100% collateralized but < 100% *liquid* assets

Crisis: < 100% collateralized

What are these assets?

- Seigniorage shares: Endogenous "equity shares"
- Basis: Endogenous bonds
- Reserve-backed: some portfolio

DAI (PSM) Schematic



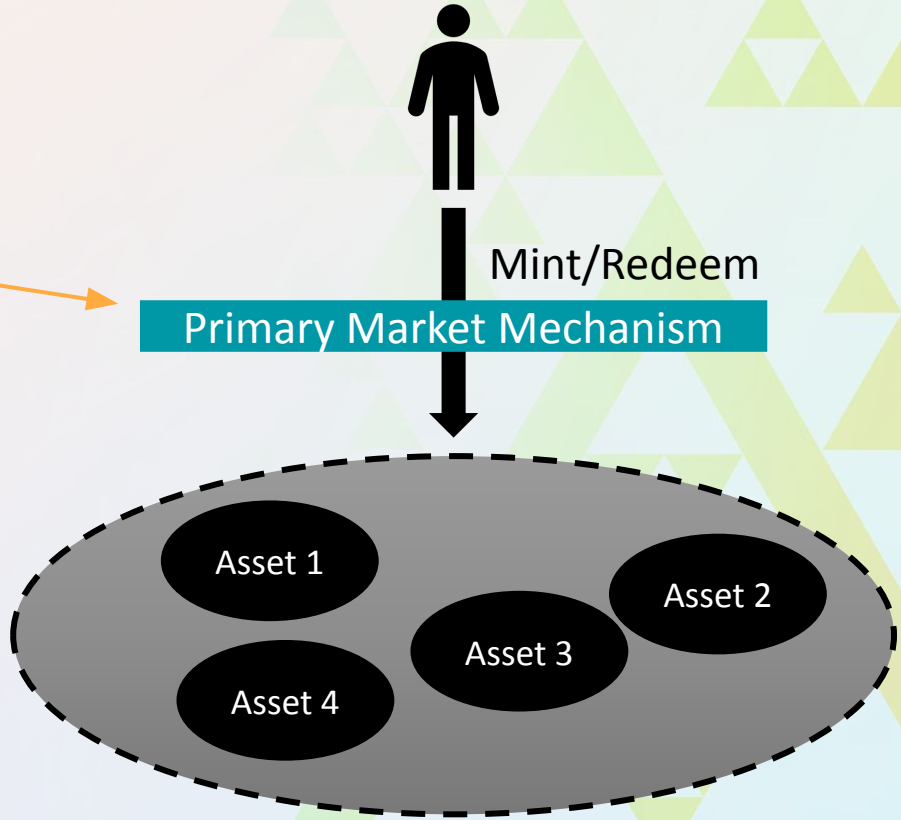
≈ 60% of DAI = PSM USDC collateral
(+ 20% DAI-USDC LP)

- Counterparty Risk?
- Censorship Risk?

Goal: Build a “PSM 2.0”

1. Diversified PSM reserves
2. Programmatic risk control
    a. coordinated PSM strategies
    b. contingency pricing

A Simple Primary Market Model

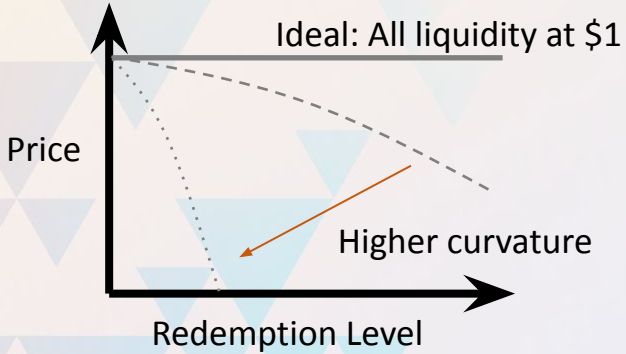


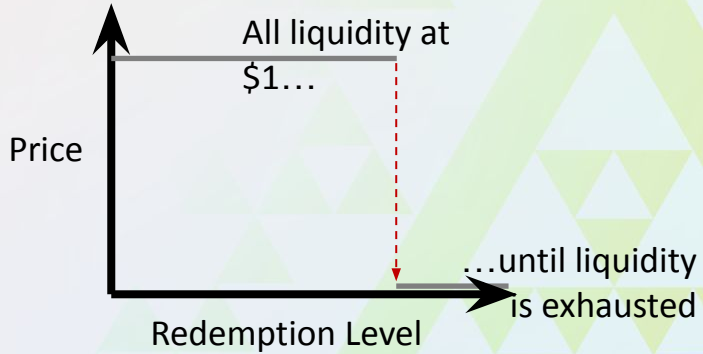
Questions for the reserve:

- What assets? Which risks?
- How to structure the reserve / manage risk?
- How to generate yield?
- How to price reserve assets? (oracles)

Redemption Curves

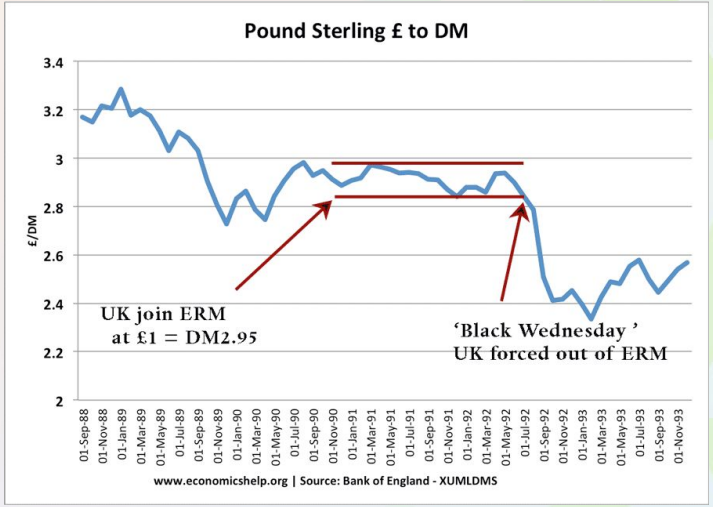
Redemption curve = price of redemption as fn. of total redemptions



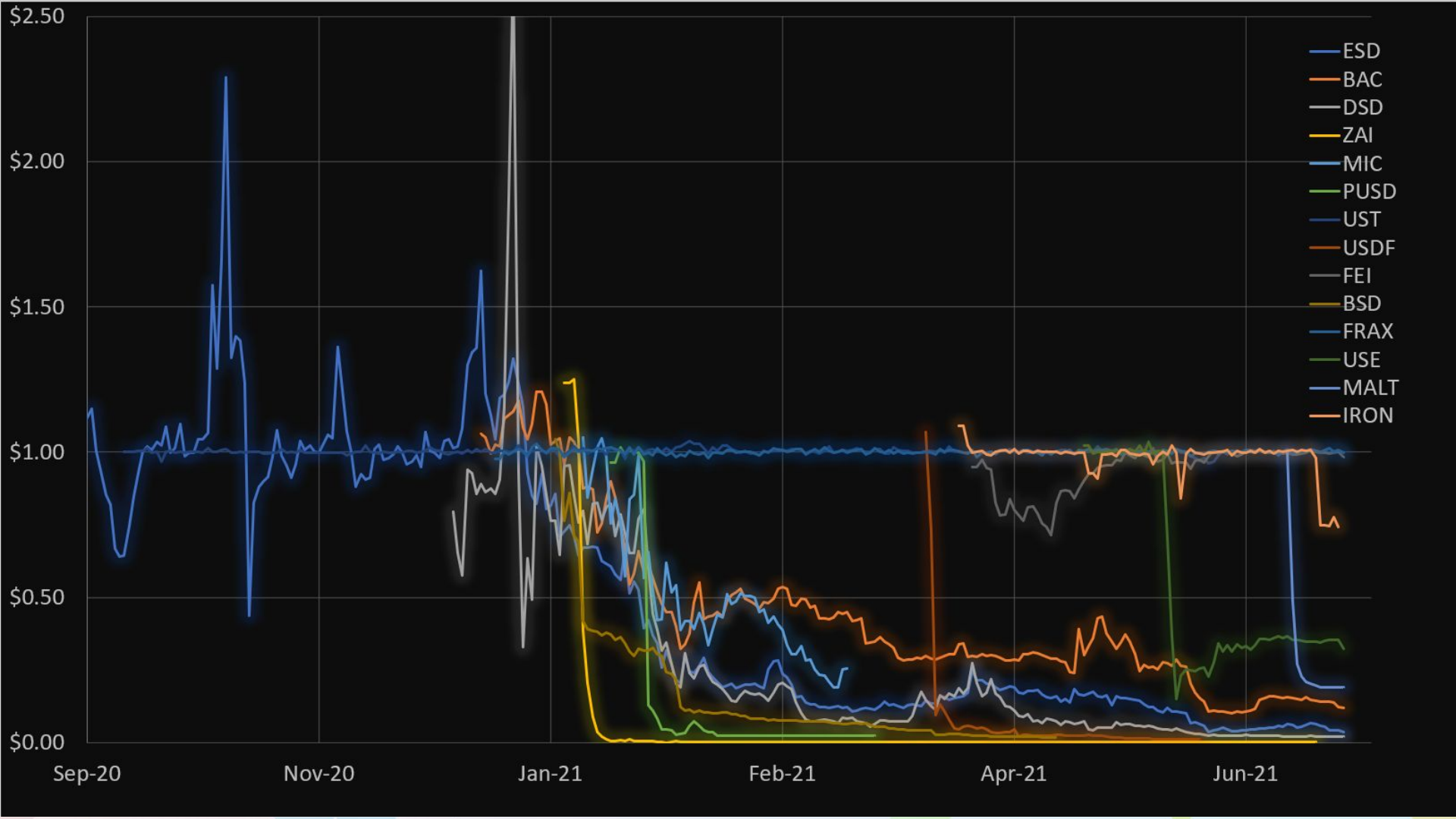


Speculative Attacks

- E.g., Soros attack on GBP



- Studied in international finance literature (e.g., Morris and Shin, 1998)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BAC
DSD
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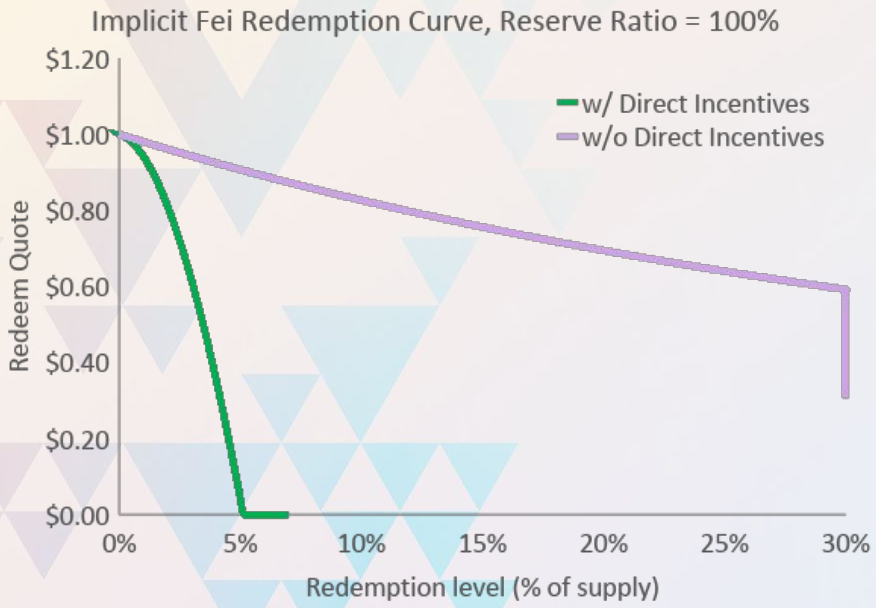
UST
USDF
FEI
BSD
FRAX
USE
MALT
IRON

Algorithmic Primary Markets

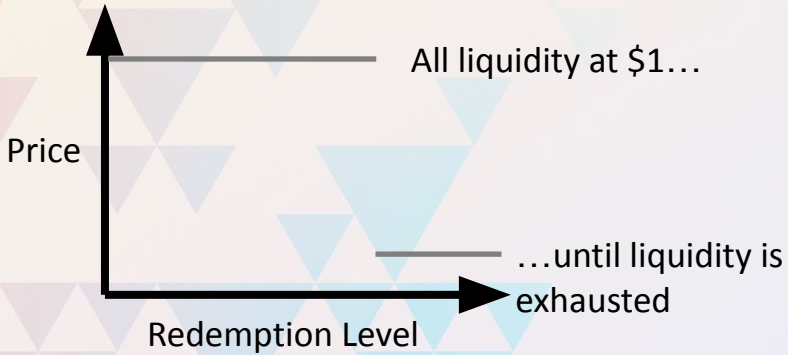
Case study: Fei (original design)



Algorithmic Primary Markets

Case study: Seigniorage shares

- $1 redemption, but backing = endogenous asset
- ⚠️ Negative feedback spirals




UST: Price
Data from 04/22/2022 (UTC) to 05/31/2022 (UTC)
UST Price (Close)
UST Volume Indicator
UST
Fri, 6 May 4:45pm
EST:
Steffen gives 1st
version of this talk.
$0.100
$0.0213
2
25
28
May
4
7
10
13
16
19
22
25
28
31


UST: Circulating Supply
Data from 04/22/2022 (UTC) to 05/31/2022 (UTC)
Supply


LUNC: Price
Data from 04/22/2022 (UTC) to 05/31/2022 (UTC)
LUNC Price (Close)
LUNC Volume Indicator
LUNA
$10.00
$0.001
25
28
May
4
7
10
13
16
19
22
25
28
31


LUNC: Circulating Supply
Data from 04/22/2022 (UTC) to 05/31/2022 (UTC)
Supply

Precedent: The IRON crash (June 2021)

IRON stablecoin:

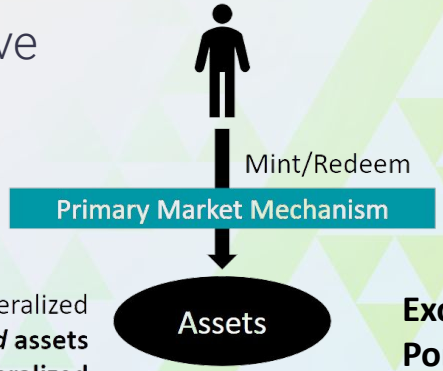
TITAN endogenous asset backing:

Designing an Automatic Primary Market

Idea: Choose a redemption curve, implement it in the Primary Market.

Results

1. Desiderata for any “good” redemption curve
2. Specify one such curve
3. Implementation ⇒ Dynamic bonding curve



Normal times: ≥ 100% collateralized
Possibly: < 100% *liquid* assets
Crisis: < 100% collateralized

Redemption Curve Desiderata, Within Blocks

1. Collateralization ≥ lower bound, if possible
2. Redemption price ≥ lower bound, if possible
3. Normally redemption price ≈ $1
4. Continuous, not too steep, if possible
5. No incentive to subdivide redemptions

Bonus: Redemption Curve Desiderata, Across Blocks

6. Reserve exhaustion takes a long time (unless exogenous)
7. De-pegged stablecoin can regain peg
8. Efficient implementation

Measure of redemption level

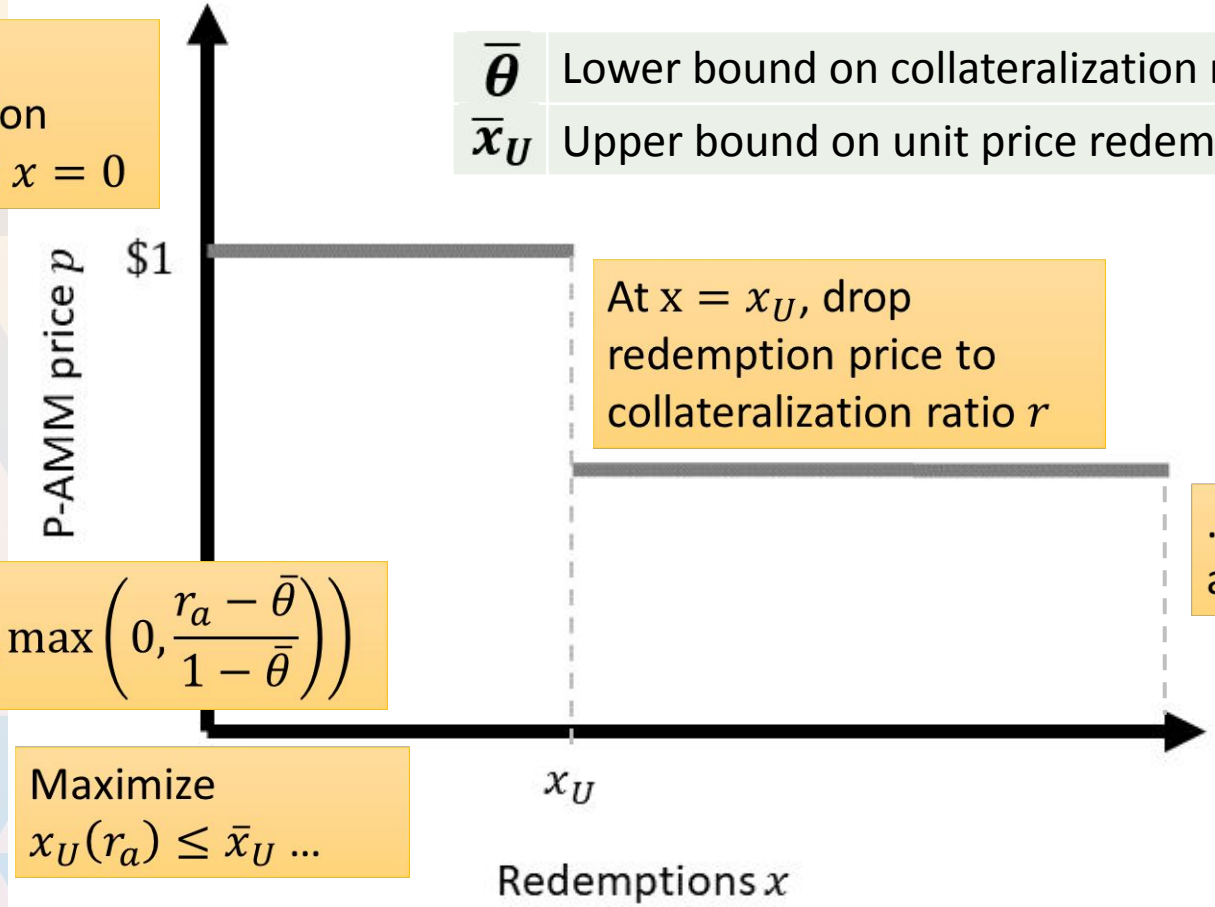
Time-discounted sum:

$$\sum_{t \le T} \delta^{T-t} \cdot (\text{amount of redemptions at t})$$

Simplified Redemption Curve Design: Discrete

WLOG collateralization $r_a \in (\bar{\theta}, 1)$ at $x = 0$

$\bar{\theta}$	Lower bound on collateralization ratio, if possible
$\bar{x}_U$	Upper bound on unit price redemption level



At $x = x_U$, drop redemption price to collateralization ratio r

... s.t. $r \geq \bar{\theta}$ always

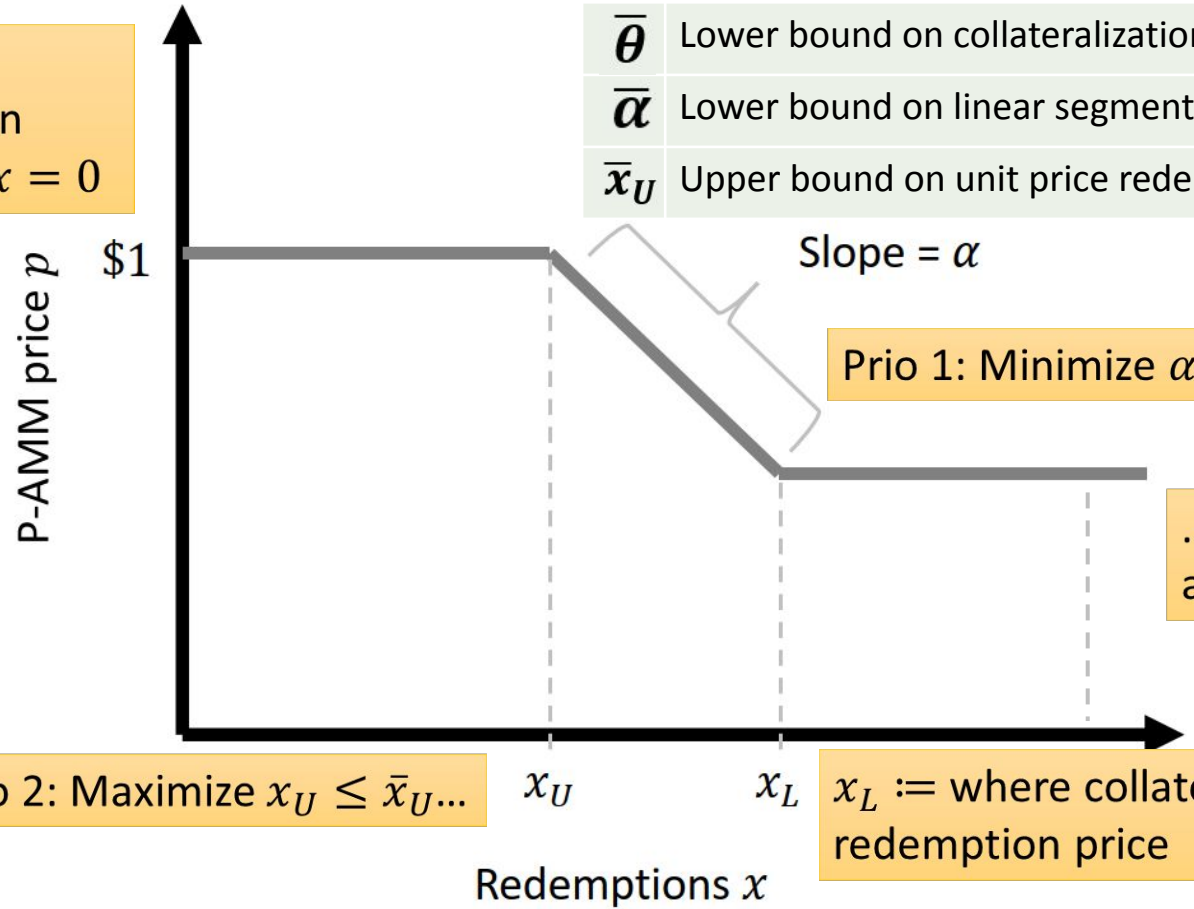
$$x_U = \min\left(\bar{x}_U, \max\left(0, \frac{r_a - \bar{\theta}}{1 - \bar{\theta}}\right)\right)$$

Maximize $x_U(r_a) \leq \bar{x}_U$ ...

A Piecewise-Linear Redemption Curve

WLOG collateralization $r_a \in (\bar{\theta}, 1)$ at $x = 0$

$\bar{\theta}$	Lower bound on collateralization ratio, if possible
$\bar{\alpha}$	Lower bound on linear segment slope
$\bar{x}_U$	Upper bound on unit price redemption level



Prio 1: Minimize $\alpha \geq \bar{\alpha}$…

… s.t. $r \geq \bar{\theta}$ always

Prio 2: Maximize $x_U \leq \bar{x}_U$…

x_L ≔ where collateralization = redemption price

Computing Parameters of the Curve

$$\alpha = \max(\bar{\alpha}, \hat{\alpha}) \text{ where}$$

$$\hat{\alpha} = \begin{cases} \hat{\alpha}_H := 2\frac{1-r_a}{y_a}, & r_a \geq \frac{1+\bar{\theta}}{2} \\ \hat{\alpha}_L := \frac{1}{2}\frac{\theta^2}{b_a - \bar{\theta} y_a}, & r_a \leq \frac{1+\bar{\theta}}{2} \end{cases}$$

$$x_U = \min(\bar{x}_U, \hat{x}_U) \text{ where}$$

$$\hat{x}_U = \begin{cases} \hat{x}_{U,h} := y_a - \sqrt{2\frac{\Delta_a}{\alpha}}, & \alpha\Delta_a \leq \frac{1}{2}\theta^2 \\ \hat{x}_{U,l} := y_a - \frac{\Delta_a}{\theta} - \frac{1}{2\alpha}\theta & \alpha\Delta_a \geq \frac{1}{2}\theta^2. \end{cases}$$

$$x_L = y_a - \sqrt{(y_a - x_U)^2 - \frac{2}{\alpha}(y_a - b_a)}$$

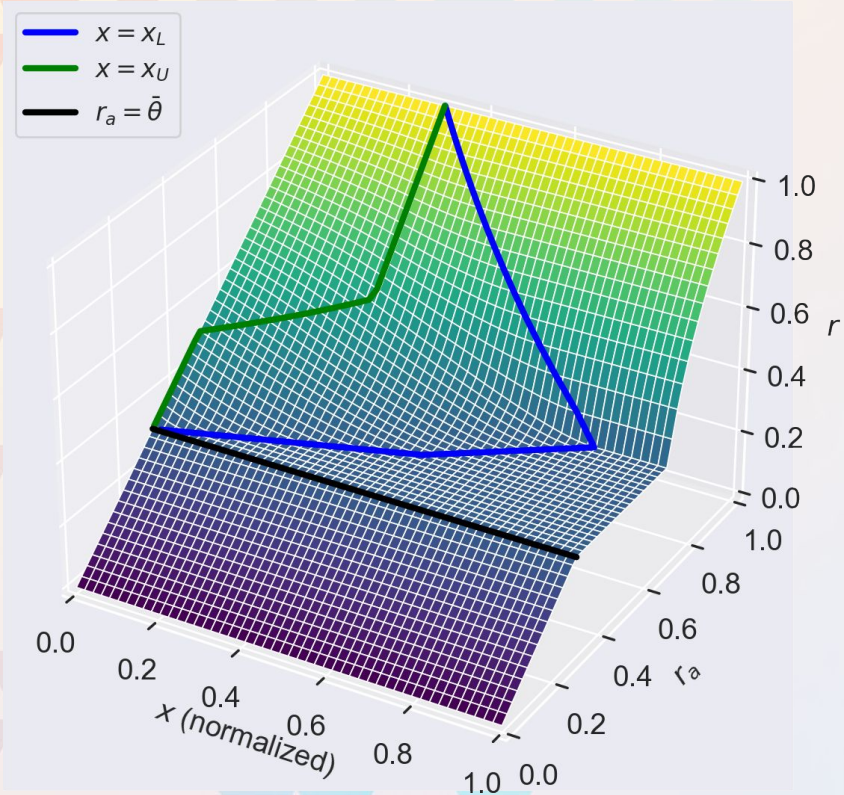
$$r_L = 1 - \alpha(x_L - x_U)$$

Here: $y_a := 1, b_a := r_a$

Now make it dynamic!

→ React to the *current* market state

Backing out the Anchor Point from the Current Market State

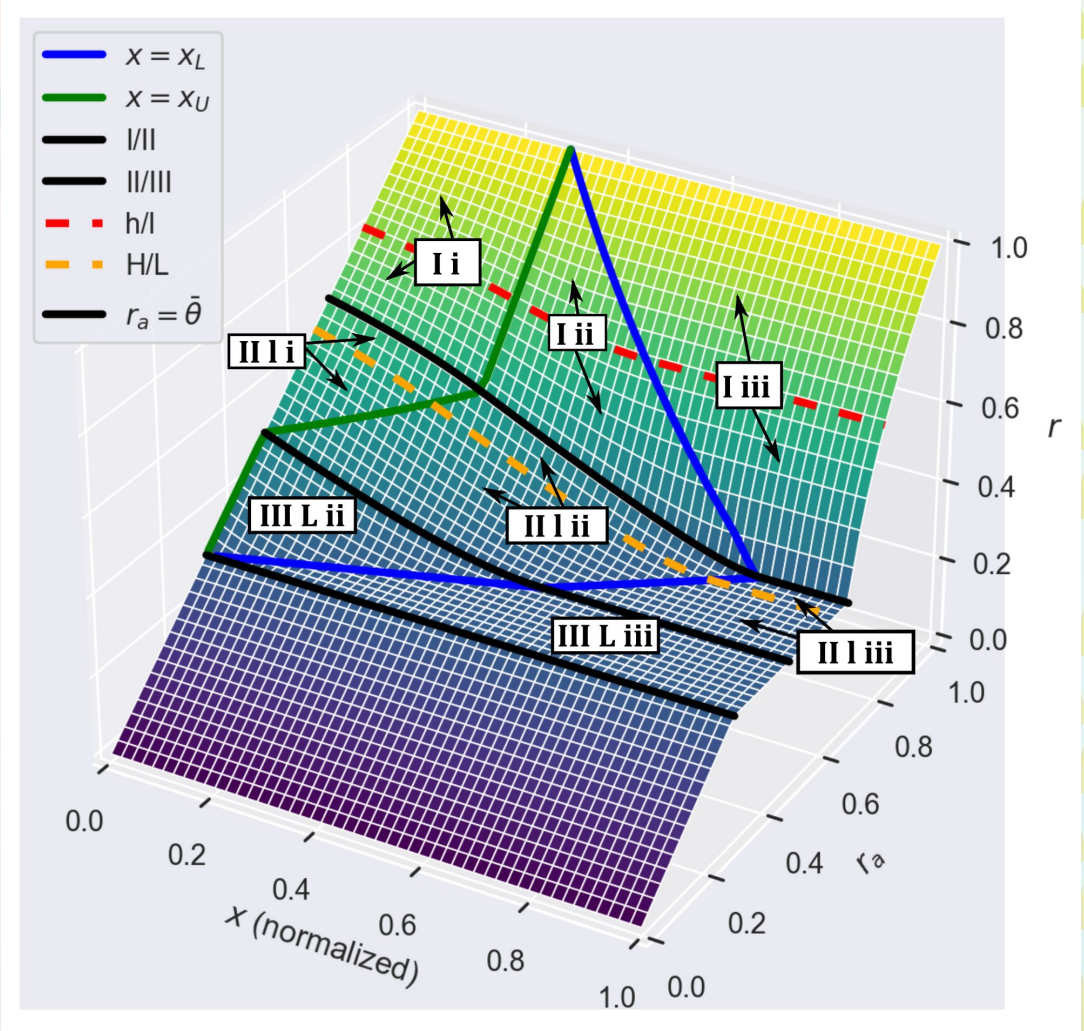


Theorem: For any fixed redemption level x, the collateralization ratio $\boldsymbol{r}$ **at** $\boldsymbol{x}$ **is strictly monotonic in** $\boldsymbol{r_a}$, as long as $r > \bar{\theta}$.

Corollary: There is a unique r_a that leads to a given pair (x, r).

Implementation: State Regions

Theorem: We can efficiently determine the current region without knowledge of r_a.



Reconstructing the Anchor Point

Theorem: Given the region, x, and r, we can efficiently compute r_a.

Proof: Within regions, everything is quadratic and smooth; use the quadratic formula!

Implementation of redemption operation

Algorithm:

1. Detect the region of the current state.
2. Reconstruct r_a.
3. Compute the redemption amount.

Implementation: Const # arithmetic ops + ≤ 2 sqrts

Path Properties

Result (path independence): No incentive to split up redemptions

Result (path deficiency): Protocol state only improves across mint/redeem paths

Theorem 3. *Let* $\mathfrak{r} \in \mathcal{R}$ *such that* $\mathfrak{r} \leq 1$. *Then for all* $f \in \mathcal{C}$ *and for all* $t \in [0,1]$, *we have* $\mathfrak{r}\big(f(t)\big) \leq r_{f,\mathfrak{r}}(t)$.

Conclusion: Design Your Redemption Curve!

- Compare stablecoins by their **redemption curve**
  - = Redemption price as fct. of redemption amount
- Idea: *Design* a desirable redemption curve
- Design: Piecewise-linear adaptive redemption curve
- Then make it dynamic!

⇒ **Gyroscope's Dynamic Stability Mechanism (DSM)**

Read the DSM paper!

Thank you!

GYROSCOPE

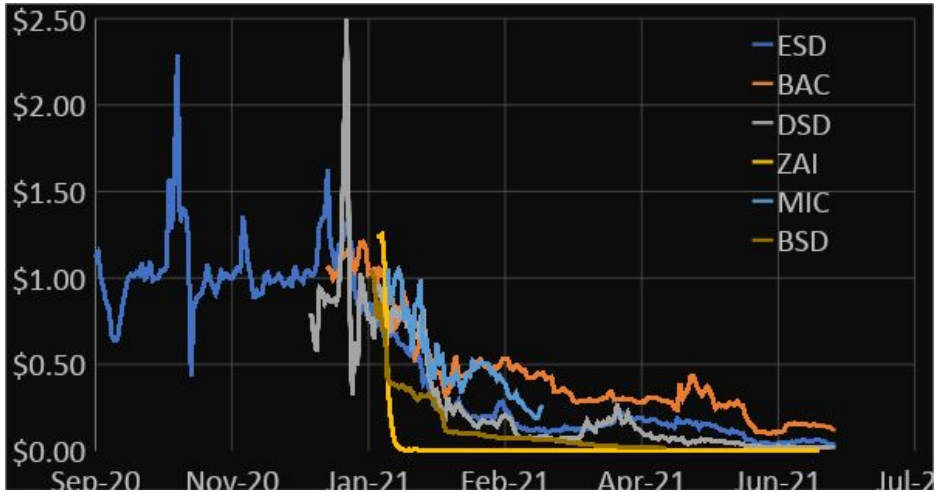
→ gyro.finance / @gyrostable

Appendix

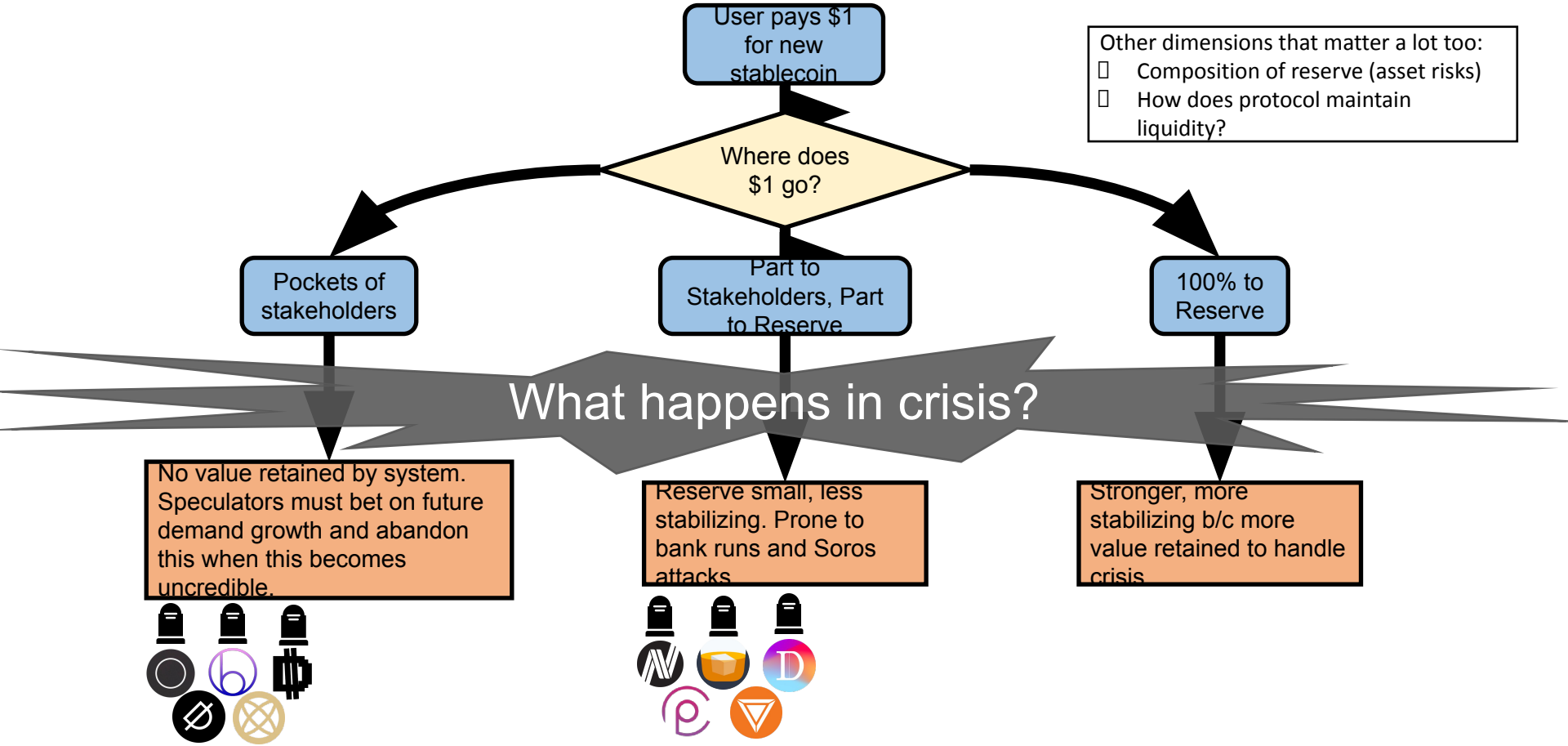
Algorithmic Primary Markets

Case study 1: Basis/ESD

- Implicit redemption curve for endogenous “coupons”
- When coupon demand disappears, flat at $0 (no asset backing)



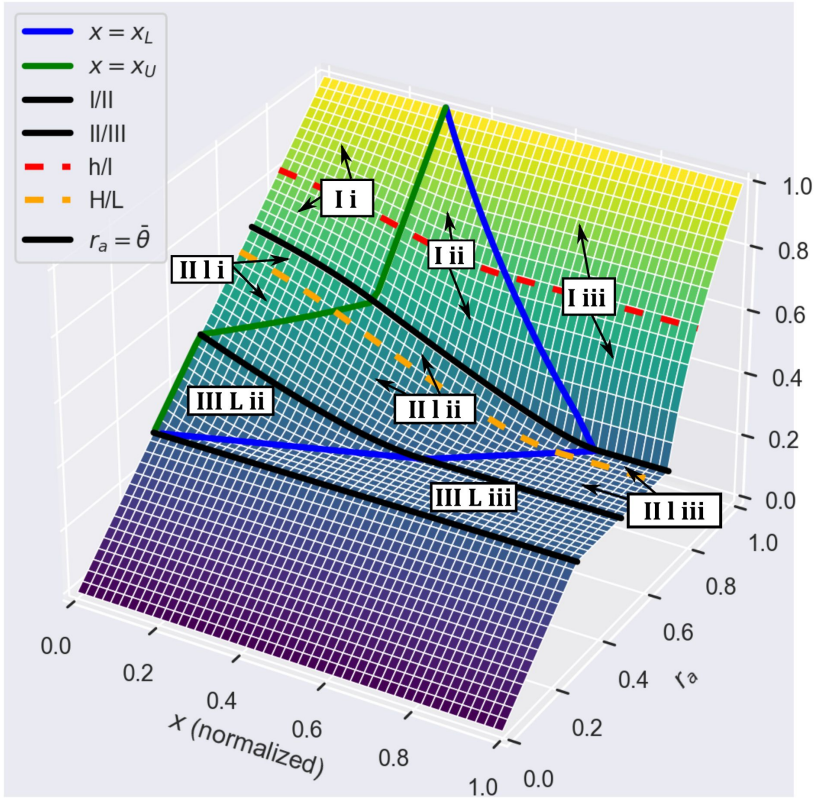
Contrasting Algorithmic Stablecoins



Other dimensions that matter a lot too:

- Composition of reserve (asset risks)
- How does protocol maintain liquidity?

State Regions



State Regions along 3 dimensions:

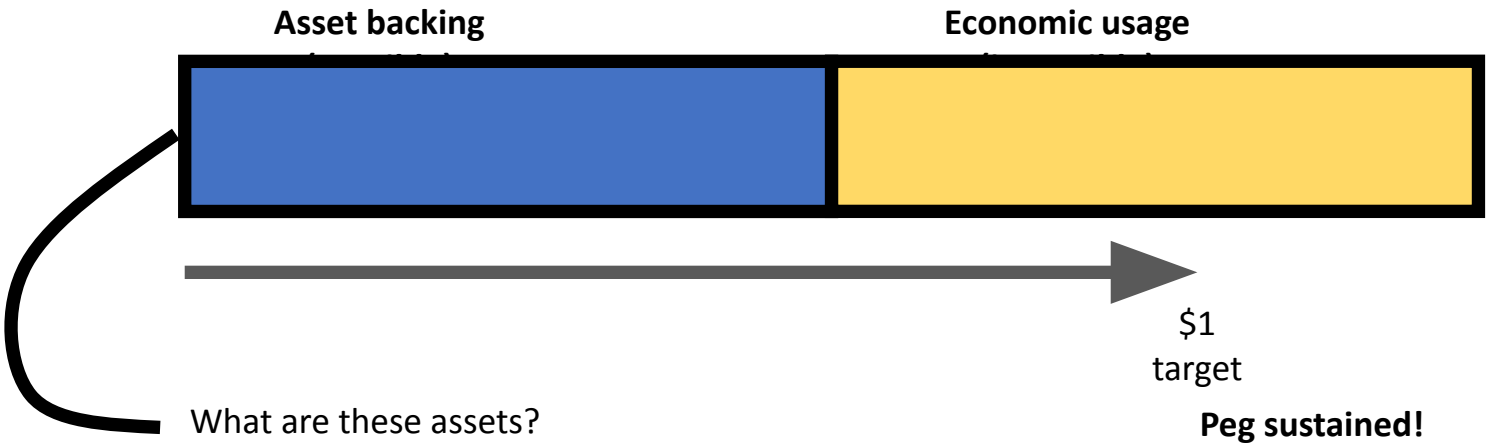
I–III: Is $x_U = \bar{x}_U$? Is $\alpha = \bar{\alpha}$?

i –iii: In which segment (constant, linear, constant) is x?

h, l: From computation of α, x_U.

Theorem: We can efficiently determine the current region without knowledge of r_a.

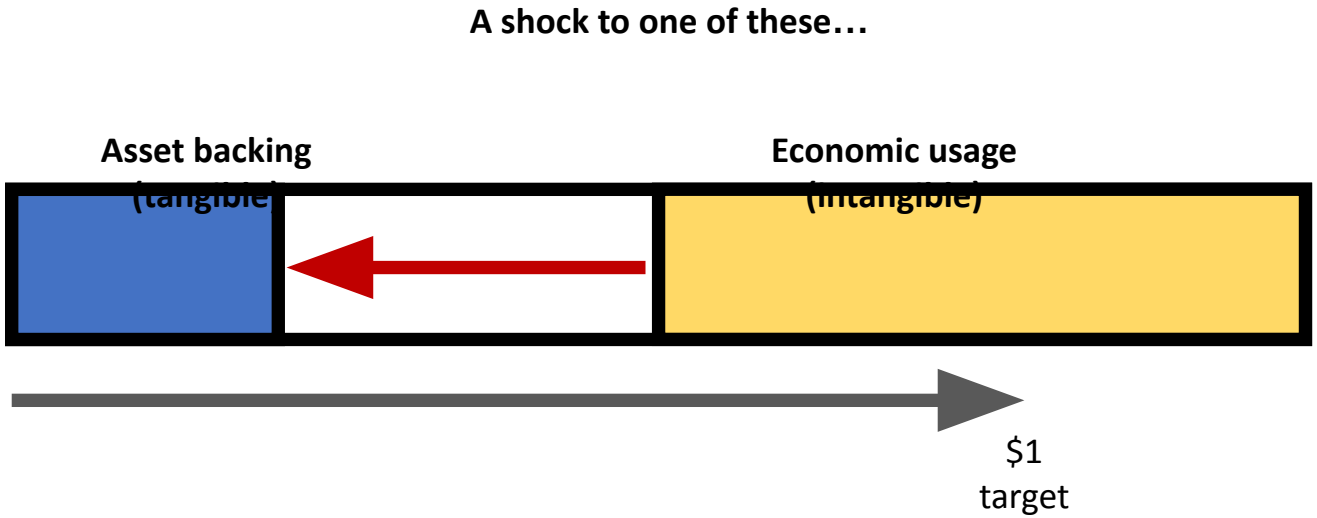
What Backs a Currency Peg?



What are these assets?

- Seigniorage shares: value of endogenous “equity shares”
- Basis: nothing!
- Reserve-backed: some portfolio

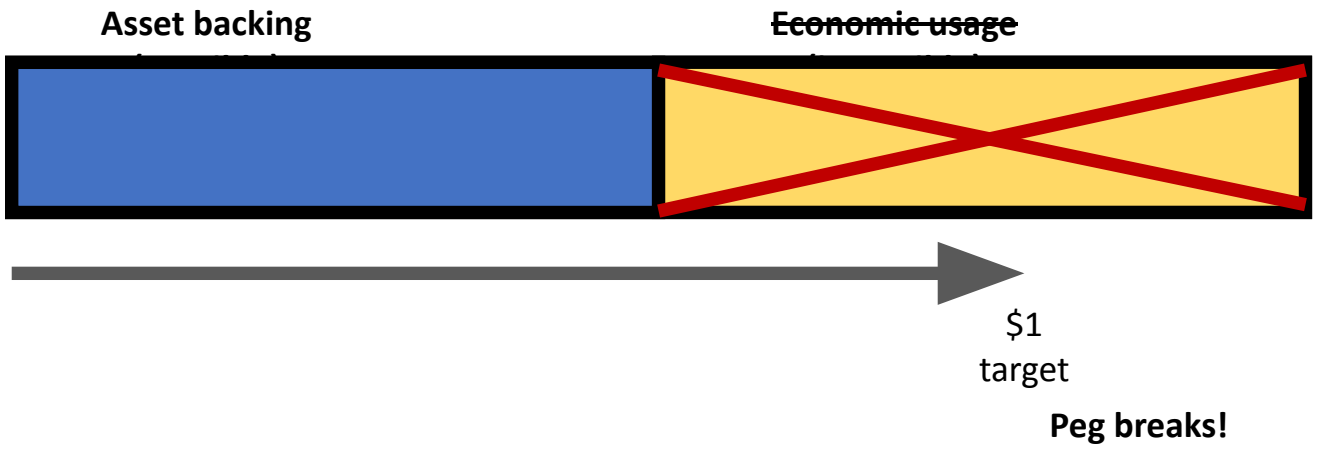
What Backs a Currency Peg?



What Backs a Currency Peg?

A shock to one of these…

What Backs Algorithmic Stablecoins?



Algorithmic Primary Markets

Case study 1: USDC/USDT

- Flat redemption curve at $1
- ⚠️ Off-chain ⇒ must trust issuer
- Dai PSM wrapped version of this

Appendix

Section 1

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Section 3

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Here’s the timeline.

Event 1

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Event 2

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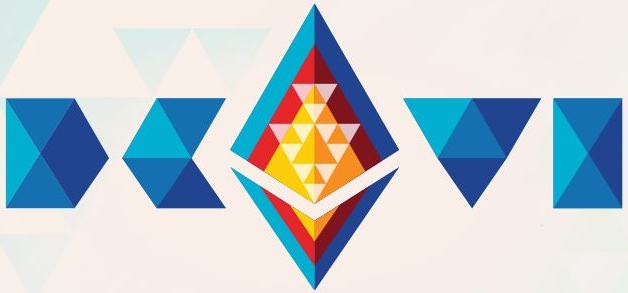

Thank you!

Your Name

Your title, your organization

email@emailaddress.com

@twitterhandle