Designing Autonomous Markets for Stablecoin Monetary Policy

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A Simple Primary Market Model

Normal times: $\geq 100\%$ collateralized
Possibly: $\geq 100\%$ 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)
Algorithmic Primary Markets

Case study: Fei (original design)

Implicit Fei Redemption Curve, Reserve Ratio = 100%

Redeem Quote

$0.00 $0.20 $0.40 $0.60 $0.80 $1.00 $1.20

Redemption level (% of supply)

0% 5% 10% 15% 20% 25% 30%
Case study: Seigniorage shares
- $1 redemption, but backing = endogenous asset
- ⚠ Negative feedback spirals

Algorithmic Primary Markets

Price

Redemption Level

All liquidity at $1...

...until liquidity is exhausted
Fri, 6 May 4:45pm EST:
Steffen gives 1\textsuperscript{st} version of this talk.
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
6. Reserve exhaustion takes a long time (unless exogenous)
7. De-pegged stablecoin can regain peg
8. Efficient implementation

Bonus: Redemption Curve Desiderata, Across Blocks
Measure of redemption level

Time-discounted sum:

$$\sum_{t \leq T} \delta^{T-t} \cdot (\text{amount of redemptions at } t)$$
Simplified Redemption Curve Design: Discrete

WLOG collateralization

\( r_a \in (\tilde{\theta}, 1) \) at \( x = 0 \)

\( \theta \) 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 \( r \)

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

Maximize

\[
x_U(r_a) \leq \bar{x}_U ...
\]

\( x_U \)

Redemptions \( x \)

\( \text{s.t. } r \geq \tilde{\theta} \) always
A Piecewise-Linear Redemption Curve

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

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td>$\bar{\theta}$</td>
<td>Lower bound on collateralization ratio, if possible</td>
</tr>
<tr>
<td>$\bar{\alpha}$</td>
<td>Lower bound on linear segment slope</td>
</tr>
<tr>
<td>$\bar{x}_U$</td>
<td>Upper bound on unit price redemption level</td>
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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

Slope = $\alpha$
Computing Parameters of the Curve

\[ \alpha = \max(\bar{\alpha}, \hat{\alpha}) \]
where

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

\[ x_U = \min(\bar{x}_U, \hat{x}_U) \]
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 $r$ at $x$ is strictly monotonic in $r_a$, as long as $r > \bar{r}$.

**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 $r_a$. 

![Image with graph and labels]
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 + $\leq 2$ 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 $r \in R$ such that $r \leq 1$. Then for all $f \in C$ and for all $t \in [0,1]$, we have $r(f(t)) \leq r_{f,r}(t)$. 
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)

Thank you!

→ 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

User pays $1 for new stablecoin

Where does $1 go?

- Pockets of stakeholders
- Part to Stakeholders, Part to Reserve
- 100% to Reserve

No value retained by system. Speculators must bet on future demand growth and abandon this when this becomes uncredible.

Reserve small, less stabilizing. Prone to bank runs and Soros attacks.

Stronger, more stabilizing b/c more value retained to handle crisis.

Other dimensions that matter a lot too:
- Composition of reserve (asset risks)
- How does protocol maintain liquidity?
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 $\alpha, x_U$.

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?

A shock to one of these...

Asset backing (tangible) | Economic usage (intangible)

$1 target
What Backs a Currency Peg?

A shock to one of these…

Asset backing (tangible)  Economic usage (intangible)

$1 target

Peg breaks!
What backs Algorithmic Stablecoins?

- **Asset backing (tangible)**
- **Economic usage (intangible)**

$1 target

**Peg breaks!**
Algorithmic Primary Markets

Case study 1: USDC/USDT

- Flat redemption curve at $1
-⚠️ Off-chain ⇒ must trust issuer
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