# Can Stablecoins be Stable?

Adrien d'Avernas
*Stockholm School of Economics*

Vincent Maurin
*Stockholm School of Economics*

Quentin Vandeweyer
*Chicago Booth*

2023 EFA Conference

# Stablecoins

- Stablecoin: crypto pegged to a traditional currency (USD, EUR, ...)

  $\rightarrow$ allegedly combine benefits of blockchains with stability of traditional money

- Stablecoins' market value grew from \$3B in 2019 to $\sim$ \$125B in 2023

- Regulatory scrutiny worldwide

## Stablecoins

- Stablecoin: crypto pegged to a traditional currency (USD, EUR, ...)

  $\rightarrow$ allegedly combine benefits of blockchains with stability of traditional money

- Stablecoins' market value grew from \$3B in 2019 to $\sim$ \$125B in 2023

- Regulatory scrutiny worldwide

- Large design heterogeneity across platforms issuing stablecoins

  $\rightarrow$ governance, peg mechanism, issuance rules, collateral backing (if any!)

**What make stablecoins stable?**

# This Paper

**Model**

- Demand: users get time-varying liquidity benefits from stablecoins
- Supply: monopolistic platform maximizes seigniorage revenues

# This Paper

**Model**

- Demand: users get time-varying liquidity benefits from stablecoins
- Supply: monopolistic platform maximizes seigniorage revenues

**Key Friction: Optimal stablecoin monetary policy is time-inconsistent**

$\rightarrow$ platform overissues to dilute past users ($\sim$ Coase) $\rightarrow$ peg is lost

# This Paper

**Model**

- Demand: users get time-varying liquidity benefits from stablecoins
- Supply: monopolistic platform maximizes seigniorage revenues

**Key Friction: Optimal stablecoin monetary policy is time-inconsistent**

$\rightarrow$ platform overissues to dilute past users ($\sim$ Coase) $\rightarrow$ peg is lost

**Results**

- Commitment: demand fluctuations $\rightarrow$ issuance and repurchase
  $\rightarrow$ fragility of algo. stablecoins: peg lost after large demand drop
- No commitment: collateral helps with stability but not commitment

# This Paper

**Model**

- Demand: users get time-varying liquidity benefits from stablecoins
- Supply: monopolistic platform maximizes seigniorage revenues

**Key Friction: Optimal stablecoin monetary policy is time-inconsistent**

$\rightarrow$ platform overissues to dilute past users ($\sim$ Coase) $\rightarrow$ peg is lost

**Results**

- Commitment: demand fluctuations $\rightarrow$ issuance and repurchase
  $\rightarrow$ fragility of algo. stablecoins: peg lost after large demand drop
- No commitment: collateral helps with stability but not commitment
- **Decentralized issuance** restores commitment

# Outline

## Stablecoin Demand

- Continuous time $t \in [0, \infty)$ and common discount rate $r$

- Stablecoin $= \infty$-maturity asset, pays interest $\delta_t$ (in stablecoins), price $p_t$

- Mass $1$ of users value consumption $x_t$ and real stablecoin balances $p_t c_t$

$$(x_t + u_t(p_t c_t))dt \qquad \text{(utility flow)}$$

$\rightarrow$ money in the utility $\approx$ transaction benefits from holding stablecoins

## Stablecoin Demand

- Continuous time $t \in [0, \infty)$ and common discount rate $r$
- Stablecoin $= \infty$-maturity asset, pays interest $\delta_t$ (in stablecoins), price $p_t$
- Mass $1$ of users value consumption $x_t$ and real stablecoin balances $p_t c_t$

$$(x_t + u_t(p_t c_t))dt \qquad \text{(utility flow)}$$

$\rightarrow$ money in the utility $\approx$ transaction benefits from holding stablecoins

- Investors' optimization $\Rightarrow$ competitive stablecoin price

$$p_t = p_t \delta_t dt + p_t u_t'(p_t c_t)dt + (1 - rdt)\mathbb{E}_t[p_{t+dt}]$$

# Stablecoin Demand

- Continuous time $t \in [0, \infty)$ and common discount rate $r$
- Stablecoin $= \infty$-maturity asset, pays interest $\delta_t$ (in stablecoins), price $p_t$
- Mass $1$ of users value consumption $x_t$ and real stablecoin balances $p_t c_t$

$$(x_t + u_t(p_t c_t))dt \qquad \text{(utility flow)}$$

  $\rightarrow$ money in the utility $\approx$ transaction benefits from holding stablecoins

- Investors' optimization $\Rightarrow$ competitive stablecoin price

$$p_t = p_t \delta_t dt + p_t u_t'(p_t c_t) dt + (1 - r dt)\mathbb{E}_t[p_{t+dt}]$$

- Market clearing $c_t = C_t$ (supply) $\rightarrow$ sufficient statistics for demand is

$$\ell_t = u_t'(p_t C_t)$$

# Liquidity Benefit

- Liquidity benefit $\ell_t =$ flow demand function for stablecoins

# Liquidity Benefit

- Liquidity benefit $\ell_t$ = flow demand function for stablecoins
- $\ell_t$ fluctuates with exogenous demand shock $A_t$ (for given real stock $p_t C_t$)

$$dA_t = \underbrace{\mu A_t dt + \sigma A_t dZ_t}_{\text{geometric brownian motion}} + \underbrace{A_{t^-}(S_t - 1)dN_t}_{\downarrow \text{jumps}}$$

  - ▷ stochastic demand with expected growth rate
  - ▷ $\downarrow$ jump: sudden drop in demand

# Liquidity Benefit

- Liquidity benefit $\ell_t$ = flow demand function for stablecoins

- $\ell_t$ fluctuates with exogenous demand shock $A_t$ (for given real stock $p_t C_t$)

$$dA_t = \underbrace{\mu A_t dt + \sigma A_t dZ_t}_{\text{geometric brownian motion}} + \underbrace{A_{t^-}(S_t - 1)dN_t}_{\downarrow \text{jumps}}$$

  - ▷ stochastic demand with expected growth rate
  - ▷ ↓ jump: sudden drop in demand

- **Peg assumption**: liquidity benefit enjoyed only under price peg

$$\ell_t = \ell(A_t, C_t)\mathbf{1}_{p_t=1}$$

→ captures extreme preference for stability (e.g. coins as means of payment)

# Stablecoin Supply: Centralized Case

- Stablecoin platform chooses monetary policies to maximize revenues:
  - Stablecoin issuance and buyback policy $\{d\mathcal{G}_t\}_{t\geq 0}$ at market price $p_t$
  - Interest flow payment to stablecoin owners $\{\delta_t\}_{t\geq 0}$ in stablecoins

$$\underbrace{dC_t}_{\Delta \text{ stablecoin}} = d\mathcal{G}_t + \delta_t C_t dt$$

# Stablecoin Supply: Centralized Case

- Stablecoin platform chooses monetary policies to maximize revenues:
  - ▷ Stablecoin issuance and buyback policy $\{d\mathcal{G}_t\}_{t\geq 0}$ at market price $p_t$
  - ▷ Interest flow payment to stablecoin owners $\{\delta_t\}_{t\geq 0}$ in stablecoins

$$\underbrace{dC_t}_{\Delta \text{ stablecoin}} = d\mathcal{G}_t + \delta_t C_t dt$$

  - ▷ Collateralization ratio $\varphi \in [0, 1]$:

$$\text{collateral value} = \varphi C_t$$

- Collateral: liquid and safe asset, with return $\mu^k \leq r \rightarrow$ holding cost

## Stablecoin Supply: Centralized Case

- Stablecoin platform chooses monetary policies to maximize revenues:
  - Stablecoin issuance and buyback policy $\{d\mathcal{G}_t\}_{t\geq 0}$ at market price $p_t$
  - Interest flow payment to stablecoin owners $\{\delta_t\}_{t\geq 0}$ in stablecoins

$$\underbrace{dC_t}_{\Delta \text{ stablecoin}} = d\mathcal{G}_t + \delta_t C_t dt$$

  - Collateralization ratio $\varphi \in [0, 1]$:

$$\text{collateral value} = \varphi C_t$$

- Collateral: liquid and safe asset, with return $\mu^k \leq r \to$ holding cost
- Monopolistic platform internalizes effect of policies on equilibrium price

$$p_t = \mathbb{E}_t \left[ \int_t^{\infty} \left( \ell(A_s,\ C_s) \mathbf{1}_{p_s=1} + \delta_s \right) p_s e^{-r(s-t)} ds \right]$$

# Outline

# Unlimited Commitment Benchmark

- Platform chooses at date $0$ policies for all dates $t \geq 0$

  $\rightarrow$ unlimited commitment = unlimited liability (relaxed later)

# Unlimited Commitment Benchmark

- Platform chooses at date $0$ policies for all dates $t \geq 0$

  $\rightarrow$ unlimited commitment $=$ unlimited liability (relaxed later)

- Monopolistic platform's problem simplifies to:

$$E_0 = \max_{\varphi, \{C_\tau\}_{\tau \geq 0}} \mathbb{E}\left[ \int_0^\infty e^{-rt} \Big( \underbrace{\ell(A_t, C_t) C_t \mathbf{1}_{p_t = 1}}_{\text{seignoriage revenue flow}} - \underbrace{(r - \mu^k)\varphi C_t}_{\text{collateral cost flow}} \Big) dt \right]$$

## Unlimited Commitment Benchmark

- Platform chooses at date $0$ policies for all dates $t \geq 0$

  $\rightarrow$ unlimited commitment = unlimited liability (relaxed later)

- Monopolistic platform's problem simplifies to:

$$E_0 = \max_{\varphi, \{C_\tau\}_{\tau \geq 0}} \mathbb{E}\left[\int_0^\infty e^{-rt}\Big(\underbrace{\ell(A_t, C_t)C_t \mathbf{1}_{p_t=1}}_{\text{seignoriage revenue flow}} - \underbrace{(r-\mu^k)\varphi C_t}_{\text{collateral cost flow}}\Big)dt\right]$$

subject to

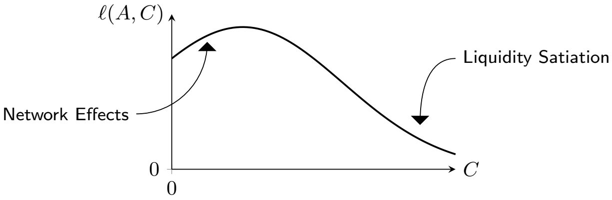
$$p_t = \mathbb{E}_t\left[\int_t^\infty (\ell(A_s, C_s)\mathbf{1}_{p_s=1} + \delta_s)\, p_s e^{-r(s-t)} ds\right] \qquad \text{(Comp. Pricing)}$$

# Unlimited Commitment: Stable Equilibrium

**Stable Equilibrium with Unlimited Commitment**

The optimal policies that support a stable equilibrium ($p_t = 1 \; \forall t$) are:

- $\varphi^\star = 0$ (no collateral)
- stablecoin stock: $C^\star(A_t) = \arg\max_C \ell(A_t, C)C = A_t / a^\star$
- interest-rate on stablecoin: $\delta^\star = r - \ell(A, C^\star(A))$

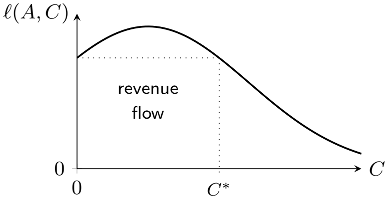


# Unlimited Commitment: Stable Equilibrium

**Stable Equilibrium with Unlimited Commitment**

The optimal policies that support a stable equilibrium ($p_t = 1 \; \forall t$) are:

- $\varphi^\star = 0$ (no collateral)
- stablecoin stock: $C^\star(A_t) = \arg\max_C \ell(A_t, C)C = A_t/a^\star$
- interest-rate on stablecoin: $\delta^\star = r - \ell(A, C^\star(A))$



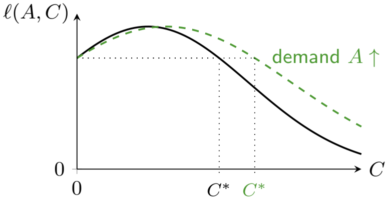

- Implementation with open-market operations

# Unlimited Commitment: Stable Equilibrium

**Stable Equilibrium with Unlimited Commitment**

The optimal policies that support a stable equilibrium ($p_t = 1\ \forall t$) are:

- $\varphi^\star = 0$ (no collateral)
- stablecoin stock: $C^\star(A_t) = \arg\max_C \ell(A_t, C)C = A_t/a^\star$
- interest-rate on stablecoin: $\delta^\star = r - \ell(A, C^\star(A))$



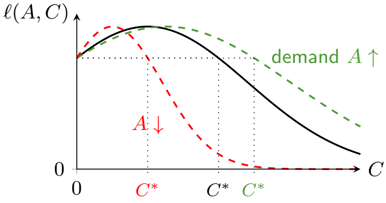

- Implementation with open-market operations

# Unlimited Commitment: Stable Equilibrium

**Stable Equilibrium with Unlimited Commitment**

The optimal policies that support a stable equilibrium ($p_t = 1\ \forall t$) are:

- $\varphi^\star = 0$ (no collateral)
- stablecoin stock: $C^\star(A_t) = \arg\max_C \ell(A_t, C)C = A_t/a^\star$
- interest-rate on stablecoin: $\delta^\star = r - \ell(A, C^\star(A))$



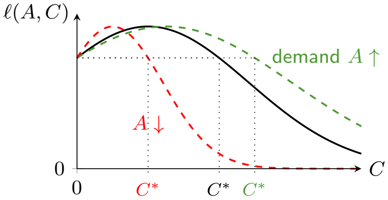

- Implementation with open-market operations

# Unlimited Commitment: Stable Equilibrium

**Stable Equilibrium with Unlimited Commitment**

The optimal policies that support a stable equilibrium ($p_t = 1\ \forall t$) are:

- $\varphi^\star = 0$ (no collateral)
- stablecoin stock: $C^\star(A_t) = \arg\max_C \ell(A_t, C)C = A_t/a^\star$
- interest-rate on stablecoin: $\delta^\star = r - \ell(A, C^\star(A))$




- Implementation with open-market operations
- What if repurchases must be financed with plaftorm's wealth?

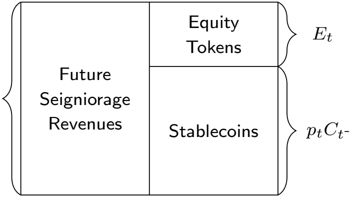
# Stablecoin Repurchases

- **Limited liability constraint**: equity value $E_t \geq 0$ at all times $t$

# Stablecoin Repurchases

- **Limited liability constraint**: equity value $E_t \geq 0$ at all times $t$

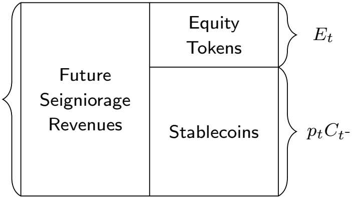
$$\mathbb{E}\left[\int_t^{\infty} e^{-r(s-t)} \underbrace{\ell(A_s, C_s) C_s \mathbf{1}_{p_s=1}}_{\text{revenue flow}} ds \,\middle|\, A_t\right]$$



# Stablecoin Repurchases

- **Limited liability constraint**: equity value $E_t \geq 0$ at all times $t$

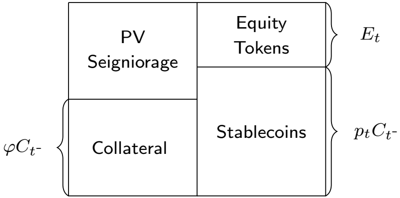
$$\mathbb{E}\left[\int_t^\infty e^{-r(s-t)} \underbrace{\ell(A_s, C_s) C_s \mathbf{1}_{p_s=1}}_{\text{revenue flow}} ds \,\middle|\, A_t\right]$$



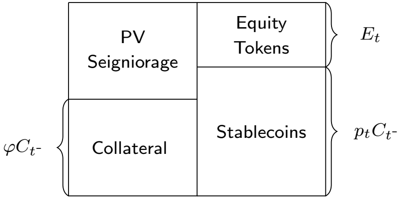

- Algo. implementation of policy in "normal" times (e.g. Terra):
  - ▷ Demand $A \uparrow$ sell stablecoins, pay dividends (buy back equity tokens)
  - ▷ Demand $A \downarrow$ buy back stablecoins by selling equity tokens

- Large $\downarrow\downarrow$ shock to demand $\rightarrow$ devaluation is unavoidable: $p_t < 1$

# A Role for Collateral



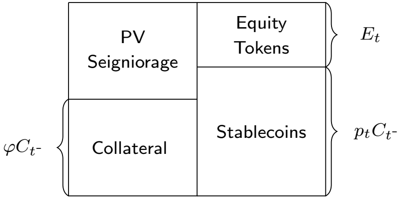
# A Role for Collateral




- Collateral relaxes limited liability constraint, $E_t \geq 0$

$$E_t = \mathbb{E}\left[\int_t^{\tau} e^{-r(s-t)}\Big(\ell(A_s, C_s)C_s - (r-\mu^k)\varphi C_s\Big)ds \,\Big|\, A_t\right] - (p_t - \varphi)C_{t^-}$$

## A Role for Collateral

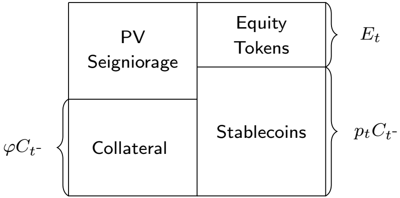



- Collateral relaxes limited liability constraint, $E_t \geq 0$

$$E_t = \mathbb{E}\left[\int_t^\tau e^{-r(s-t)}\Big(\ell(A_s, C_s)C_s - (r-\mu^k)\varphi C_s\Big)ds \Big| A_t\right] - (p_t - \varphi)C_{t\text{-}}$$

- Optimal $\varphi^\star$ trades off collateral cost with stability benefits

# A Role for Collateral




- Collateral relaxes limited liability constraint, $E_t \geq 0$

$$E_t = \mathbb{E}\left[\int_t^\tau e^{-r(s-t)}\Big(\ell(A_s, C_s)C_s - (r-\mu^k)\varphi C_s\Big)ds \Big| A_t\right] - (p_t - \varphi)C_{t\text{-}}$$

- Optimal $\varphi^\star$ trades off collateral cost with stability benefits

**Narrow Stablecoin ($\varphi^\star = 1$) under Commitment**

A fully collateralized stablecoin is stable. It is profitable if $\mu^k \geq r - \ell(a^\star)$.

# Outline

# Discretionary Issuance

- **Discretionary issuance/repurchase**: $d\mathcal{G}_t$ now decided sequentially

- **Motivation**: difficulty to implement commitment rule with smart contract
  - smart contract = automatic rule executed on blockchain
  - distinction on-chain info vs. off-chain info (harder to embed)
  - commitment rule depends on stablecoin outstanding $C_{t^-}$ and demand $A_t$

- Commitment to other policies chosen at date $0$ is maintained:
  - interest rate $\delta$
  - collateralization ratio $\varphi$

- Next: intuition for commitment problem + decentralized issuance model

# Time-Consistency Problem: Intuition



- Consider fully collateralized platform ($\varphi = 1$)
- Full commitment: policy maximizes date-$0$ value of platform

$$C_t = C^\star(A_t) = \arg\max_C \left[\ell(A_t, C) - (r - \mu^k)\right] C$$

$$\delta_t = \delta^\star = r - \ell(A, C^\star(A))$$

# Time-Consistency Problem: Intuition



- Consider fully collateralized platform ($\varphi = 1$)
- Full commitment: policy maximizes date-$0$ value of platform

$$C_t = C^\star(A_t) = \arg\max_C \Big[\ell(A_t, C) - (r - \mu^k)\Big] C$$

$$\delta_t = \delta^\star = r - \ell(A, C^\star(A))$$

- Platform with $C_{t-dt}$ stablecoins outstanding can reoptimize at date $t$

$$E_t = \underbrace{C_{t-dt}}_{\text{collateral}} + \underbrace{\int_{s=t}^{\infty} e^{-r(s-t)} \Big[\ell(A_s, C_s)\mathbf{1}_{p_s=1} - (r - \mu^k)\Big] C_s dt}_{\text{PV seigniorage}} - \underbrace{p_t C_{t-dt}}_{\text{MV debt}}$$

# Time-Consistency Problem: Intuition



- Consider fully collateralized platform ($\varphi = 1$)

- Full commitment: policy maximizes date-0 value of platform

$$C_t = C^\star(A_t) = \arg\max_C \left[\ell(A_t, C) - (r - \mu^k)\right] C$$

$$\delta_t = \delta^\star = r - \ell(A, C^\star(A))$$

- Platform with $C_{t-dt}$ stablecoins outstanding can reoptimize at date $t$

$$E_t = \underbrace{C_{t-dt}}_{\text{collateral}} + \underbrace{\int_{s=t}^{\infty} e^{-r(s-t)} \left[\ell(A_s, C_s)\mathbf{1}_{p_s=1} - (r - \mu^k)\right] C_s dt}_{\text{PV seigniorage}} - \underbrace{p_t C_{t-dt}}_{\text{MV debt}}$$

subject to $\quad p_t = \ell(A_t, C_t)\mathbf{1}_{p_t=1} dt + \delta^* dt + (1 - r dt)\mathbb{E}_t[p_{t+dt}]$

# Time-Consistency Problem: Intuition



- Consider fully collateralized platform ($\varphi = 1$)
- Full commitment: policy maximizes date-0 value of platform

$$C_t = C^\star(A_t) = \arg\max_C \left[\ell(A_t, C) - (r - \mu^k)\right] C$$

$$\delta_t = \delta^\star = r - \ell(A, C^\star(A))$$

- Platform with $C_{t-dt}$ stablecoins outstanding can reoptimize at date $t$

$$E_t = \underbrace{C_{t-dt}}_{\text{collateral}} + \underbrace{\int_{s=t}^{\infty} e^{-r(s-t)} \left[\ell(A_s, C_s)\mathbf{1}_{p_s=1} - (r - \mu^k)\right] C_s dt}_{\text{PV seigniorage}} - \underbrace{p_t C_{t-dt}}_{\text{MV debt}}$$

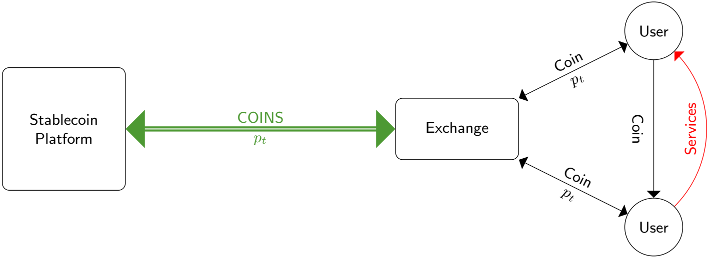
subject to $\quad p_t = \ell(A_t, C_t)\mathbf{1}_{p_t=1} dt + \delta^* dt + (1 - r dt)\mathbb{E}_t[p_{t+dt}]$

- Choosing $C_t > C^\star(A_t)$ lowers price of new and **past** stablecoins issued

  $\rightarrow$ past stablecoins = platform debt $\Rightarrow$ incentives to dilute with inflation ($\downarrow p_t$)

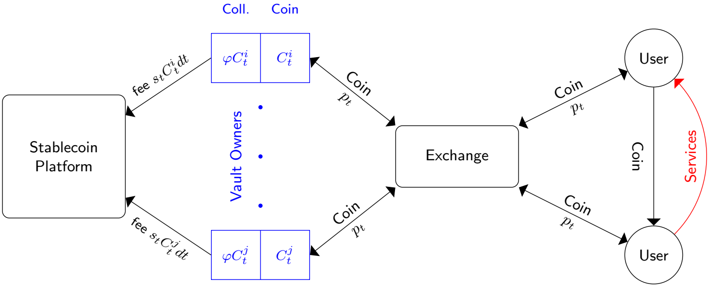
# Outline

# Decentralized Issuance



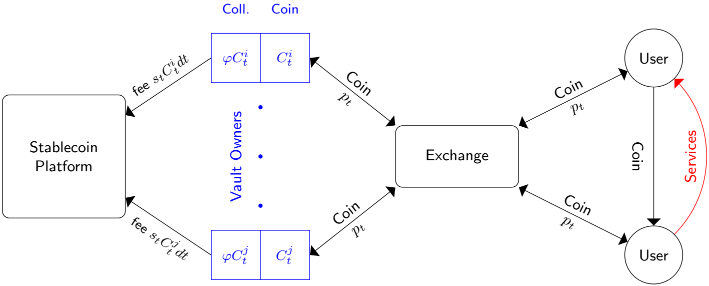

- Centralized: issuance $d\mathcal{G}_t$ chosen directly by the platform

# Decentralized Issuance




- Centralized: issuance $d\mathcal{G}_t$ chosen directly by the platform
- Decentralized: issuance delegated to small (atomistic) vault owners
  - anyone can open a vault subject to collateral requirement $\varphi$/stablecoin
  - platform's income: fee $s_t dt$ per coin outstanding charged to vault owners

# Decentralized Issuance




- Centralized: issuance $d\mathcal{G}_t$ chosen directly by the platform
- Decentralized: issuance delegated to small (atomistic) vault owners
  - ▷ anyone can open a vault subject to collateral requirement $\varphi$/stablecoin
  - ▷ platform's income: fee $s_t dt$ per coin outstanding charged to vault owners
- Platform uses fee $s_t$ to pay interest rate $\delta_t$ $\rightarrow$ profit flow $(s_t - \delta_t)p_t C_t dt$

# Why Decentralization Works?

- Decentralized issuance changes the way platform earns income:
  - Centralized: profit flow $\propto$ new issuance $p_t(C_t - C_{t-dt})$
  - Decentralized: profit flow $\propto$ total stablecoin stock $C_t$:

$$(s_t - \delta_t)p_t C_t = \ell(A_t, C_t)p_t C_t \mathbf{1}_{p_t=1} - (r - \mu^k)C_t$$

# Why Decentralization Works?

- Decentralized issuance changes the way platform earns income:
  - ▷ Centralized: profit flow $\propto$ new issuance $p_t(C_t - C_{t-dt})$
  - ▷ Decentralized: profit flow $\propto$ total stablecoin stock $C_t$:

$$(s_t - \delta_t)p_t C_t = \ell(A_t, C_t)p_t C_t \mathbf{1}_{p_t=1} - (r - \mu^k)C_t$$

$\rightarrow$ Rental solution for Coase's monopolist

Coase

- Only commitment to collateralization ratio $\varphi = 1$ is required

  $\rightarrow$ easy to implement with smart contract

**Decentralized Issuance**

A stablecoin platform with decentralized issuance can implement the full-commitment outcome under full collateralization.

## Conclusion

- We provide a general framework to analyze stablecoin stability
- Stablecoin's peg undermined by large negative demand shocks

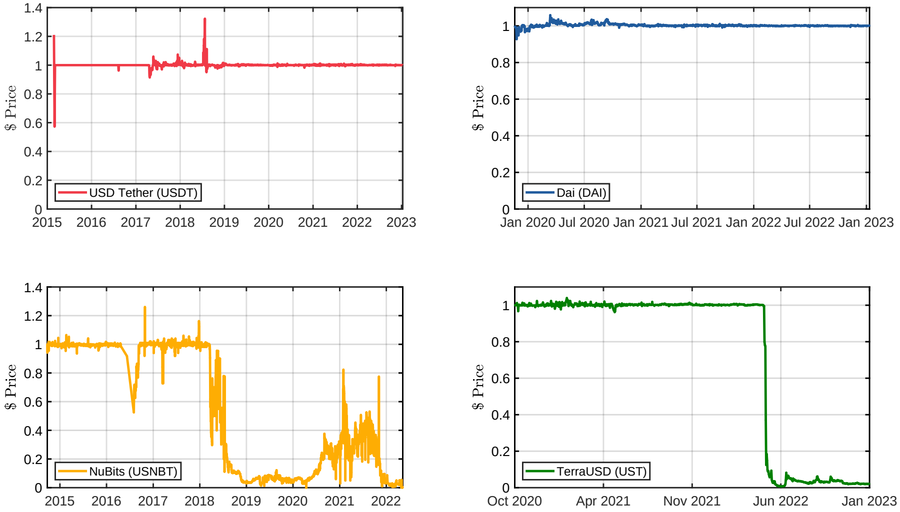
  incentives to overissue
- Collateral improves stability but does not mitigate overissuance incentives
- Decentralized design ties platform's hand via fee-based model

  $\rightarrow$ dominant stablecoins (USDT, USDC, BUSD) have instead centralized design

# APPENDIX

# Mixed Success

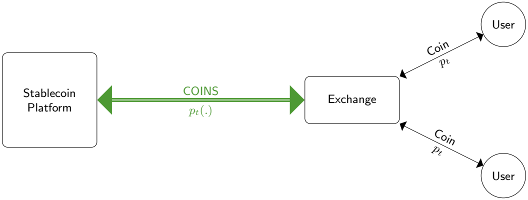
Back



# Redemption: Interpretation

Back

- Model: centralized platform issues and repurchases at market price $p_t$.

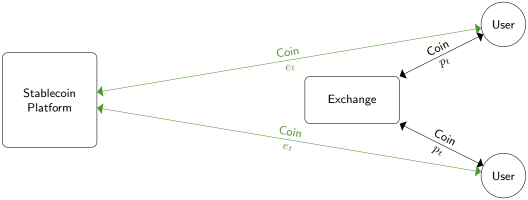


# Redemption: Interpretation

Back

- Model: centralized platform issues and repurchases at market price $p_t$.

  $\rightarrow$ What if users could redeem stablecoins with the platform at $e_t$?

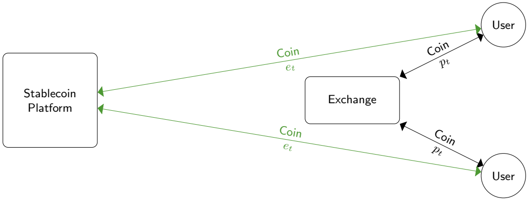


# Redemption: Interpretation



- Model: centralized platform issues and repurchases at market price $p_t$.

  $\rightarrow$ What if users could redeem stablecoins with the platform at $e_t$?




- Platform could set $e_t \Rightarrow$ stock $C_t$ adjusts by user arbitrage $p_t = e_t$

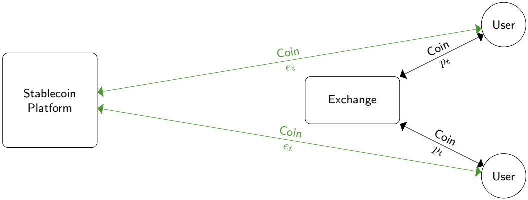
  $\rightarrow$ Monopolistic platform effectively controls market price.

# Redemption: Interpretation

Back

- Model: centralized platform issues and repurchases at market price $p_t$.

  $\rightarrow$ What if users could redeem stablecoins with the platform at $e_t$?




- Platform could set $e_t \Rightarrow$ stock $C_t$ adjusts by user arbitrage $p_t = e_t$

  $\rightarrow$ Monopolistic platform effectively controls market price.

- Difficulty: full redemption rights $\Rightarrow$ self-fulfilling runs are possible

  $\rightarrow$ Only fully collateralized platforms can credibly redeem 1:1 all stablecoins

# Limited Liability: Analysis

Back

- We solve for the optimal issuance policy in the following class

$$d\mathcal{G}_t = \begin{cases} G(A_t, C_{t^-})dt & \text{if } \ 0 \le a_t < \overline{a}, \\ \frac{A_t}{a^\star} - C_{t^-} & \text{if } \ a_t \ge \overline{a} \end{cases}$$

- Steps to characterize optimal policy:

  1. Conjecture equilibrium price: $p(a) = 1$ for $a \ge \overline{a}$ and $p(a) < 1$ otherwise
  2. $e(a) = 0$ for $a \le \overline{a} \Rightarrow G = 0$ and $\delta = 0$ for $a \le \overline{a}$
  3. Solve for $p(a)$ in smooth region $[0, \overline{a}]$
  4. Derive optimal values of thresholds $(\overline{a}, a^\star)$ that maximize platform value:

$$\frac{e(a^\star) + p(a^\star)}{a^\star} = \max_{\overline{a}, a^\star} \frac{\overbrace{\ell(a^\star)/a^\star}^{\text{revenue flow}}}{r - \underbrace{\left(\mu - \frac{\lambda}{\xi + 1}\right)}_{\mathbb{E}\left[\frac{dA}{A\,dt}\right]} + \underbrace{\left(\frac{\lambda\xi}{\xi+1} - \frac{\lambda\xi}{\xi - \gamma}\right)\left(\frac{a^\star}{\overline{a}}\right)^{-(\xi+1)}}_{\propto\ Pr[\text{lose peg}]}}$$

subject to $\quad e(\overline{a}) = \left[e(a^\star) + p(a^\star)\right]\frac{\overline{a}}{a^\star} - 1 = 0.$

# Decentralized Issuance: Problem

Back

- Platform chooses $\delta_t, s_t$ sequentially given state $(\delta_{t-\Delta t}, s_{t-\Delta t}, A_t)$

$$\Pi(\delta_{t-\Delta t}, s_{t-\Delta t}, A_t) = \max_{(s_t,\delta_t)} (s_{t-\Delta t} - \delta_{t-\Delta t})\Delta_t p_t C_{t-\Delta t} + (1 - r\Delta t)\mathbb{E}\left[\Pi(\delta_t, s_t, A_{t+\Delta t})\right]$$

$$\text{s. to} \quad p_t = l(A_t, C_t)p_t \Delta t \mathbf{1}_{p_t=1} + (1 - r\Delta t)\mathbb{E}\left[p_{t+\Delta t}(1 + \delta_t \Delta t)\right] \qquad \text{(U)}$$

$$1 - p_t = (1 - r\Delta t)\mathbb{E}\left[1 + \mu^k \Delta t - p_{t+\Delta t}(1 + s_t \Delta t)\right] \qquad \text{(V)}$$

- **Guess** Markov equilibrium implements commitment solution:
  - Policies: $(s_t, \delta_t) = (\mu^k, \delta^\star)$
  - ▷ $p^{eq}(\delta_{t-\Delta t}, s_{t-\Delta t}, A_t) = 1$
  - ▷ $C^{eq}(\delta_{t-\Delta t}, s_{t-\Delta t}, A_t) = C^\star(A_t) = \arg\max_C \left[\ell(A, C) - r + \mu^k\right] C$

- **Verify** Given $p_{t+\Delta t} = 1$ and $C_{t+\Delta t} = C^*(A_{t+\Delta t})$, optimize over $s_t, \delta_t$

# Decentralized Issuance: Markov Equilibrium

Back

- Platform's profit given $C_{t-\Delta t}, s_{t-\delta_t}, \delta_{t-\Delta t}, A_t$

$$V(\delta, s) = (s_{t-\Delta t} - \delta_{t-\Delta t})\Delta_t p_t C_{t-\Delta t} + (1 - r\Delta t)\mathbb{E}[(s_t - \delta_t)\Delta t] + K_1$$

$$= -(1-p_t)(s_{t-\Delta t} - \delta_{t-\Delta t})\Delta_t C_{t-\Delta t} + \underbrace{\Big[\ell(A_t, C_t)\mathbf{1}_{p_t=1} + \mu^k - r\Big]C_t}_{\text{maximized for } p_t=1,\ C_t=C^\star(A_t)}\Delta t + K_2$$

- Given $(s_{t-\Delta t}, \delta_{t-\Delta t}) = (\mu^k, \delta^\star)$ and $p_t \leq 1$, first term is negative

- Hence, $(s, \delta) = (\mu^k, \delta^\star)$ is optimal as it implements $p_t = 1$, $C_t = C^\star(A_t)$

- Platform lost price-setting power and thus ability to deviate

# Smart Interest Rule

Back

**Proposition 2: Optimal Policy with Nonprogrammable Issuance**

For $\varphi = 1$ (full collateralization), an interest rule can implement the commitment outcome:

$$\delta(A, C) = r - \ell(A, C)$$

- **Intuition**: smart interest rule neutralizes price impact and avoids dilution:

$$p_t = \ell(A_t, C_t)\mathbf{1}_{p_t=1}dt + \delta(A_t, C_t)dt + (1 - rdt)\mathbb{E}_t[\underbrace{p_{t+dt}}_{=1}]$$

- Ex-post, platform affects only the rental rate of stablecoin stock $\ell(A, C)$

  $\rightarrow$ rental solution to Coase's durable good monopolist problem

- Limitation: "smart" contract still require off-chain info. about demand $A_t$.

# Coasian Commitment Problem

Back 1 Back 2

- 2 period model with durable real good. Stock $\{C_t\}_{t=1,2}$
  - decreasing liquidity benefit $\ell(C)$, no demand shock
  - Good price is given by

$$p_1 = \ell(C_1) + \beta p_2$$

$$p_2 = \ell(C_2)$$

  - Issuer profit

$$\Pi_1 = p_1 C_1 + \beta \Pi_2$$

$$\Pi_2 = p_2(C_2 - C_1)$$

# Coasian Commitment Problem

Back 1 Back 2

- 2 period model with durable real good. Stock $\{C_t\}_{t=1,2}$
  - ▷ decreasing liquidity benefit $\ell(C)$, no demand shock
  - ▷ Good price is given by

$$p_1 = \ell(C_1) + \beta p_2$$

$$p_2 = \ell(C_2)$$

  - ▷ Issuer profit

$$\Pi_1 = p_1 C_1 + \beta \Pi_2 = \ell(C_1)C_1 + \beta \ell(C_2)C_2$$

$$\Pi_2 = p_2(C_2 - C_1)$$

- **Commitment**: Issuer chooses $C_1 = C_2 = \arg\max_C \ell(C)C$

## Coasian Commitment Problem

Back 1 Back 2

- 2 period model with durable real good. Stock $\{C_t\}_{t=1,2}$
  - ▷ decreasing liquidity benefit $\ell(C)$, no demand shock
  - ▷ Good price is given by

$$p_1 = \ell(C_1) + \beta p_2$$

$$p_2 = \ell(C_2)$$

  - ▷ Issuer profit

$$\Pi_1 = p_1 C_1 + \beta \Pi_2 = \ell(C_1)C_1 + \beta \ell(C_2)C_2$$

$$\Pi_2 = p_2(C_2 - C_1) = \ell(C_2)(C_2 - C_1)$$

- **Commitment**: Issuer chooses $C_1 = C_2 = \arg\max_C \ell(C)C$

- **No Commitment**: $\forall C_1$, issuer chooses $C_2 > C_1 \Rightarrow p_2^{nc} < p_2^c$

## Coasian Commitment Problem

Back 1 Back 2

- 2 period model with durable real good. Stock $\{C_t\}_{t=1,2}$
  - ▷ decreasing liquidity benefit $\ell(C)$, no demand shock
  - ▷ Good price is given by

$$p_1 = \ell(C_1) + \beta p_2$$

$$p_2 = \ell(C_2)$$

  - ▷ Issuer profit

$$\Pi_1 = p_1 C_1 + \beta \Pi_2 = \ell(C_1)C_1 + \beta \ell(C_2)C_2$$

$$\Pi_2 = p_2(C_2 - C_1) = \ell(C_2)(C_2 - C_1)$$

- **Commitment**: Issuer chooses $C_1 = C_2 = \arg\max_C \ell(C)C$
- **No Commitment**: $\forall C_1$, issuer chooses $C_2 > C_1 \Rightarrow p_2^{nc} < p_2^c$
- **Rental**: chooses rental rate $r_t \overset{eq.}{=} \ell(C_t)$ every period.

  $\rightarrow$ issuer internalizes $\Delta$ value of total stock (no commitment problem)