Topic 4.3: Stablecoins

The Bridge Between Crypto and Fiat

Joerg Osterrieder

Digital Finance

2025

What You Will Learn in This Topic

By the end of this session, you will be able to:

1. **Classify** stablecoins by design type (fiat-backed, crypto-collateralized, algorithmic)
2. **Explain** the mechanisms that maintain price stability for each type
3. **Assess** de-peg risk factors and analyze historical de-peg events
4. **Understand** the Stablecoin Trilemma and its design implications
5. **Articulate** why stablecoins face heavy regulatory scrutiny

Hands-On Component

NB10: Analyze stablecoin price stability data—examine de-peg events and compare resilience across designs.

Prerequisites: Why Price Stability Matters

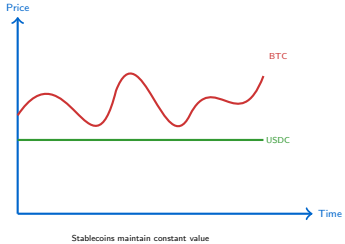
The Volatility Problem:

- Bitcoin: 60%+ annual volatility (Example: If you bought $100 of Bitcoin, it might be worth $40-$160 by year end)
- Unsuitable for everyday payments
- Merchant pricing becomes impossible
- DeFi needs stable base assets

Prior Knowledge Required:

- Basic understanding of cryptocurrency
- DeFi primitives (T4.2)
- Smart contracts (T4.1)

Quick check: If "DeFi primitives" is unfamiliar, briefly review T4.2 first.



Key Insight

Stablecoins bridge Traditional Finance (TradFi) and crypto by providing price predictability in a volatile ecosystem.

On-Chain "Cash" for the Crypto Economy

Without Stablecoins:

- Trading requires moving to fiat
- DeFi cannot price loans reliably
- Cross-border payments face friction
- No on-chain savings in stable value

Market Size (2024):

- Total supply: $170B+
- Daily volume: $50B+
- Surpasses Visa in some metrics

Use Cases:

- **Trading pairs** on exchanges
- **DeFi collateral** and lending
- **Remittances** (24/7, low fees)
- **Savings** in dollarized economies
- **Payroll** and B2B payments

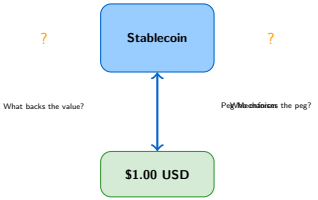
Why $1 Peg?

USD is the global reserve currency. A dollar-pegged stablecoin inherits this network effect ("network effect" means more people use dollars, so dollar-based coins are more useful).

What Are Stablecoins?

Definition

Stablecoins are cryptocurrencies designed to maintain a stable value relative to a reference asset (typically USD).



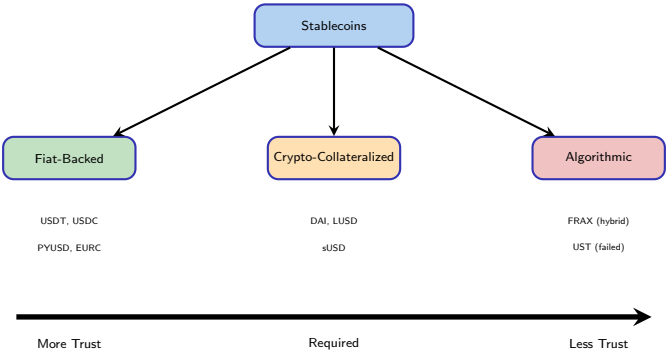
Core Challenge:

- How do you maintain $1 value without a central bank?
- Three fundamentally different approaches exist
- Each involves different trust assumptions
- No perfect solution—only trade-offs

The Central Question

How do you create "digital dollars" that maintain purchasing power without the Federal Reserve?

Stablecoin Design Taxonomy



Key Insight: Each design trades off between decentralization, capital efficiency, and stability.

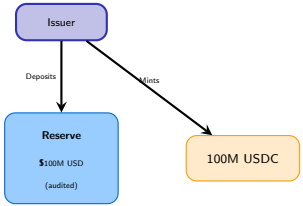
Fiat-Backed Stablecoins: How They Work

Mechanism:

1. User sends $1 to issuer
2. Issuer holds $1 in reserves
3. Issuer mints 1 stablecoin
4. User can redeem anytime

Examples:

- **USDT** (Tether): $110B, largest — "Tether USD" token
- **USDC** (Circle): $35B, regulated — "USD Coin" token
- **PYUSD** (PayPal): Newest entrant



Peg Maintenance:

- Arbitrage keeps price at $1 (arbitrage = buying low in one place and selling high in another until prices match)
- If price $>$ $1: mint and sell
- If price $<$ $1: buy and redeem

Fiat-Backed Stablecoins: Trust Requirements

What You Must Trust:

- Issuer holds stated reserves
- Reserves are liquid and accessible
- Issuer won't be hacked or defrauded
- Issuer will honor redemptions
- Banking partners remain stable

USDT Reserve Composition:

- Cash & equivalents: 85%+
- Corporate bonds: small %
- Secured loans: small %
- Other investments: small %

What could go wrong? Example: Tether faced controversy over whether reserves actually existed (2017-2021).

Centralization Risks

- Can freeze/blacklist addresses
- Regulatory seizure possible
- Single point of failure
- Opaque reserve reporting (USDT)

USDC vs USDT:

- USDC: Monthly attestations, regulated
- USDT: Less transparent, offshore
- Both: Centralized freeze capability

Key Trade-off

Fiat-backing provides strong stability but reintroduces the centralization that crypto was designed to avoid.

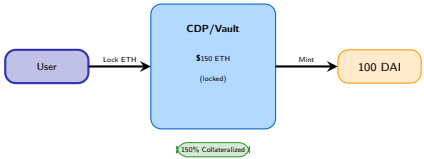
Crypto-Collateralized Stablecoins

How It Works:

1. User deposits $150 ETH
2. Protocol mints 100 DAI
3. Collateral ratio: 150%
4. If ETH drops, liquidation (like a pawn shop loan — if your collateral loses value, they sell it to cover the loan)

MakerDAO/DAI:

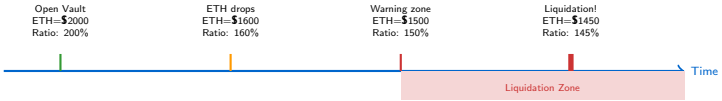
- DAI is the largest crypto-backed stablecoin
- Decentralized governance
- Multiple collateral types
- Stability fee (interest)
- Liquidation at 150%



Why Over-Collateralization?

- Crypto collateral is volatile
- 150% provides safety buffer
- Liquidation protects the peg

Liquidation Mechanics



Liquidation Process:

1. Collateral ratio falls below threshold (e.g., 150%)
2. Anyone can trigger liquidation via smart contract
3. Collateral sold at discount (liquidation penalty: 13%)
4. Debt repaid, remainder returned to vault owner

Liquidation Cascades: The Domino Effect

During market crashes, mass liquidations can cause collateral fire sales, pushing prices lower, triggering more liquidations—a dangerous feedback loop.

Think of dominoes: When one person is forced to sell, prices drop, forcing more sales, creating a chain reaction.

Crypto-Collateralized: Trade-offs

Advantages:

- ✓ **Decentralized**—no single issuer
- ✓ **Transparent**—on-chain reserves
- ✓ **Censorship-resistant**
- ✓ **No counterparty risk**
- ✓ **Auditable in real-time**

Example Protocols:

- DAI (MakerDAO)
- LUSD (Liquity)
- sUSD (Synthetix)

Disadvantages:

- × **Capital inefficient**—need \$150 for \$100
- × **Liquidation risk** for users
- × **Complex** for average users
- × **Smart contract risk**
- × **Scalability limited** by collateral

Capital Efficiency

To mint \$1B in DAI requires \$1.5B+ in collateral locked up, making it less scalable than fiat-backed alternatives.

Algorithmic Stablecoins: The Experiment

Pure Algorithmic (Failed):

- No collateral backing
- Dual-token: stable + governance
- Expand supply when above peg
- Contract supply when below peg

The Death Spiral:

1. Price drops below peg
2. Redemptions spike
3. Confidence collapses
4. Governance token crashes
5. System becomes insolvent

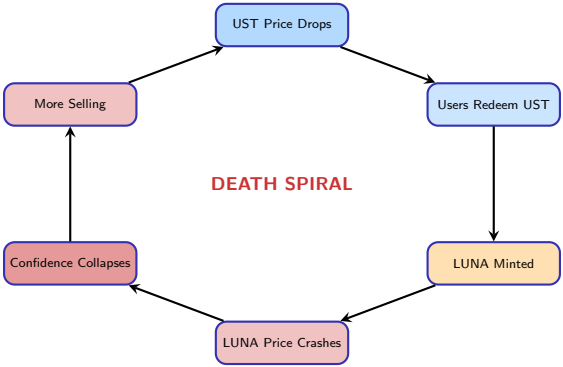
Case Study: UST/LUNA (May 2022)

- Peak market cap: $18B
- Collapsed in 72 hours
- $60B total value destroyed
- Triggered crypto contagion

Hybrid Models (Surviving):

- **FRAX**: Partially collateralized
- Dynamic collateral ratio
- More resilient to de-peg

Case Study: Terra/UST Collapse



Key Lesson: When the peg mechanism relies on a token whose value depends on confidence in the peg, you create a reflexive loop that can collapse catastrophically.

Algorithmic Mechanism: Mint/Burn

Above Peg ($1.02):

1. Arbitrageurs mint new stablecoins
2. Pay $1 worth of governance token
3. Sell stablecoin for $1.02
4. Profit: $0.02 per coin
5. Increased supply pushes price down

This direction works well.

Below Peg ($0.98):

1. Arbitrageurs buy stablecoin at $0.98
2. Redeem for $1 worth of governance token
3. Sell governance token
4. But who buys the governance token?
5. Selling pressure crashes it

This direction is fragile.

The Fundamental Problem

Algorithmic stability depends on *someone* absorbing losses during de-peg events. Without real collateral, this relies purely on confidence—which can evaporate instantly.

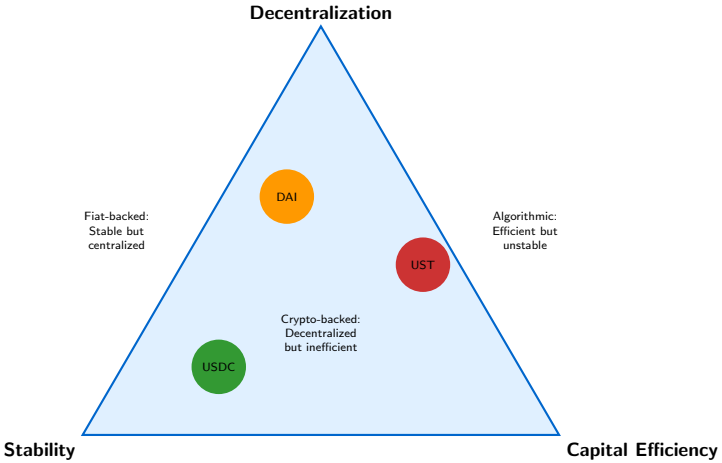
Stablecoin Design Comparison

Attribute	Fiat-Backed	Crypto-Collateral	Algorithmic
Collateral	Fiat in bank	Crypto (150%+)	None/Partial
Centralization	High	Medium	Low
Capital Efficiency	High (1:1)	Low (over-collateral)	High (0 collateral)
Scalability	Limited by reserves	Limited by collateral	Theoretically unlimited
Peg Stability	Strong	Strong	Weak
Regulatory Risk	High	Medium	Low
Censorship Risk	High	Low	Very Low

The Stablecoin Trilemma

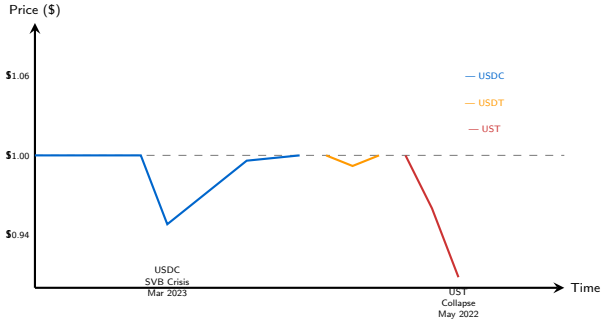
You can optimize for two of three: **Decentralization**, **Stability**, **Capital Efficiency**

The Stablecoin Trilemma



No stablecoin achieves all three. Design choices reflect priorities.

De-Peg Events: Historical Analysis



Key Lessons:

- Fiat-backed: Banking system dependencies (SVB, Silvergate)
- Algorithmic: Fundamental design flaws lead to death spirals
- All designs: Confidence is fragile and self-reinforcing

Case Study: USDC and Silicon Valley Bank

March 2023 Crisis:

1. SVB bank run announced (Mar 9)
2. Circle disclosed $3.3B in SVB
3. USDC fell to $0.87 (Mar 11)
4. Fed backstop announced (Mar 12)
5. USDC recovered to $1.00

Key Numbers:

- Total USDC supply: $43B
- SVB exposure: $3.3B (7.7%)
- Maximum de-peg: 13%
- Recovery time: 48 hours

Lessons Learned

- Fiat-backed $\neq$ risk-free
- Banking concentration is risky
- Government backstop saved USDC
- Decentralized alternatives gained attention

Circle's Response:

- Diversified banking partners
- Increased T-bill holdings
- More frequent attestations

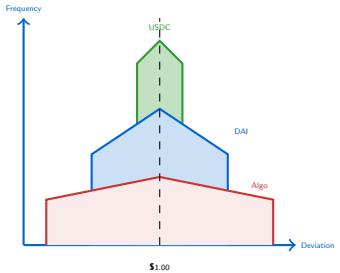
Measuring Stablecoin Stability

Key Metrics:

- **Mean deviation**: Average distance from $1
- **Max deviation**: Worst-case de-peg
- **Time in band**: % of time within $\pm 1\%$
- **Volatility**: Standard deviation of price
- **Recovery time**: Hours to return to peg

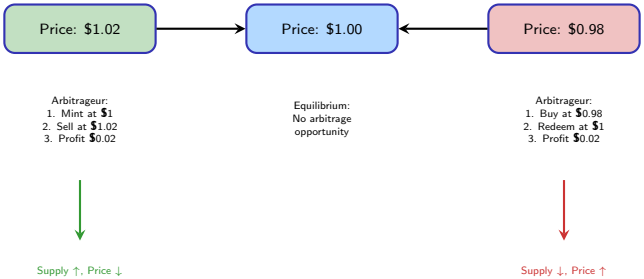
Typical Performance:

- USDC: $\pm 0.1\%$ (99% of time)
- DAI: $\pm 0.5\%$ (95% of time)
- Algorithmic: $\pm 2\%+$ (variable)



Interpretation:
Tighter distribution = more stable peg

Peg Maintenance: The Role of Arbitrage



Key Insight: Arbitrage only works if:

- Redemption is guaranteed (fiat-backed) or incentivized (algorithmic)
- Transaction costs are low enough to capture the spread
- Sufficient liquidity exists on both sides

Why Stablecoins Are Essential to DeFi:

- **Base pair** for trading (ETH/USDC, BTC/DAI)
- **Collateral** for loans (borrow against stables)
- **Settlement** for derivatives contracts
- **Yield** generation without volatility exposure

Stablecoin Yield: Where Does It Come From?

Legitimate Yield Sources:

- **Lending interest**: Borrowers pay to borrow
- **Trading fees**: DEX liquidity provision
- **Protocol incentives**: Governance tokens
- **RWA yield**: T-bills backing (4-5%)

Typical DeFi Rates:

- Lending (Aave): 2-5% APY
- Liquidity provision: 5-15% APY
- T-bill backed: 4-5% APY

Red Flags: Unsustainable Yield

- Anchor Protocol: 19.5% on UST
- "Too good to be true"
- Where does yield come from?
- **If you can't identify the source, you ARE the yield**

Risk-Return Reality:
Higher yield = Higher risk
"Safe" stablecoin yield $\approx$ T-bill rate

What's Actually Backing Stablecoins?

Asset Type	USDC	USDT	Risk Level
Cash & Bank Deposits	20%	10%	Low
US Treasury Bills	75%	80%	Very Low
Commercial Paper	0%	3%	Medium
Corporate Bonds	2%	3%	Medium
Secured Loans	0%	3%	Higher
Other Investments	3%	1%	Variable

Why Reserve Composition Matters:

- **Liquidity**: Can reserves be sold quickly during redemptions?
- **Credit risk**: Could reserve assets default?
- **Duration risk**: Are reserves affected by interest rate changes?
- **Transparency**: Are reserves independently verified?

Post-SVB Shift

Major stablecoins have shifted toward T-bills (very liquid, very safe) after the banking crisis revealed concentration risk.

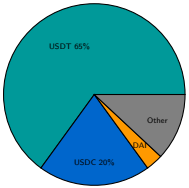
Global Stablecoin Landscape

Market Dominance (2024):

- USDT: $110B (65%)
- USDC: $35B (20%)
- DAI: $5B (3%)
- Others: $20B (12%)

Geographic Patterns:

- **USDC**: US-regulated, institutional
- **USDT**: Offshore, emerging markets
- **Euro stablecoins**: Growing (EURC)
- **Regional**: XSGD (Singapore), etc.



Growth Drivers:

- Cross-border payments
- DeFi activity
- Emerging market adoption

Analyzing Peg Stability and De-Peg Events

In the Colab notebook (NB10), you will:

1. Compare stability metrics across stablecoin types
2. Simulate crypto-collateralized stablecoin behavior
3. Model liquidation cascades under stress conditions
4. Analyze the Terra/UST death spiral dynamics
5. Calculate stability scores for different designs

Access the Notebook

`day_04/notebooks/NB10_Stablecoin_Analysis.ipynb`

Or scan QR code / click link provided

Time: 20-25 minutes for guided exploration

NB10: Key Analysis Tasks

Part 1: Stability Metrics

- Generate synthetic price data
- Calculate mean/max deviation
- Measure time within bands
- Compare across types

Part 2: Collateral Simulation

- Build a DAI-like system
- Open vaults with collateral
- Simulate price decline
- Observe liquidations

Part 3: Cascade Analysis

- Model liquidation cascades
- Vary market depth parameters
- Observe feedback effects

Part 4: Death Spiral

- Simulate algorithmic collapse
- Understand reflexivity
- Identify warning signs

Key Takeaway

Hands-on simulation reveals risks that theory alone cannot convey.

Discussion: Which Stablecoin Should You Use?

For Maximum Safety:

- USDC (fiat-backed, audited)
- Accept centralization risk
- Best for: Large holdings, institutions

For Decentralization:

- DAI (crypto-collateralized)
- Accept capital inefficiency
- Best for: DeFi natives, censorship concerns

For Higher Yield:

- Be extremely cautious
- Understand yield source
- Best for: Experienced users only

Questions to Ask:

1. What backs the stablecoin?
2. Who can freeze my funds?
3. What happens if issuer fails?
4. How transparent are reserves?
5. What's the track record?

Portfolio Approach

Many sophisticated users hold multiple stablecoins to diversify risk:

- 50% USDC (safety)
- 30% DAI (decentralization)
- 20% other (diversification)

Discussion: Stablecoins as Systemic Risk?

Why Regulators Worry:

- $170B+ in circulation
- Critical DeFi infrastructure
- Bank-like without banking rules
- Potential money laundering
- Consumer protection gaps
- "Too big to fail" concerns

Historical Parallels:

- Money market funds (2008)
- Bank runs (pre-FDIC)
- Currency crises

Counterarguments:

- More transparent than banks
- Real-time reserve verification
- Market-based discipline
- Innovation benefits

The Core Tension

Should stablecoins be regulated like banks?

- Yes: Same risks, same rules
- No: Different technology, different approach
- Hybrid: Risk-based regulation

Stablecoin Regulation

Why Regulators Care:

- Systemic risk (too big to fail?)
- Consumer protection
- Money laundering concerns
- Monetary policy implications
- Bank-like activities

Regulatory Developments:

- EU: MiCA framework (2024)
- US: Congressional debate ongoing
- Singapore: Clear framework
- China: Banned

Key Requirements Emerging

- 1:1 reserve backing
- Regular audits/attestations
- Redemption guarantees
- Segregated reserves
- Licensing requirements

Impact on Market:

- USDC: Embracing regulation
- USDT: Offshore strategy
- DAI: Decentralization defense

MiCA: Europe's Stablecoin Framework

Markets in Crypto-Assets (MiCA):

- First comprehensive crypto regulation
- Effective 2024 for stablecoins
- Applies to all EU member states

Key Stablecoin Requirements:

1. **Authorization**: Must be licensed
2. **Reserves**: 1:1 backing required
3. **Segregation**: Customer funds protected
4. **Redemption**: On-demand at par value
5. **Volume limits**: Caps on non-euro stablecoins

Two Categories:

- **EMT**: E-money tokens (single fiat)
- **ART**: Asset-referenced tokens (baskets)

Impact

- USDT delisted from some EU exchanges
- USDC becoming "compliant choice"
- Euro stablecoins emerging
- Algorithmic stablecoins effectively banned

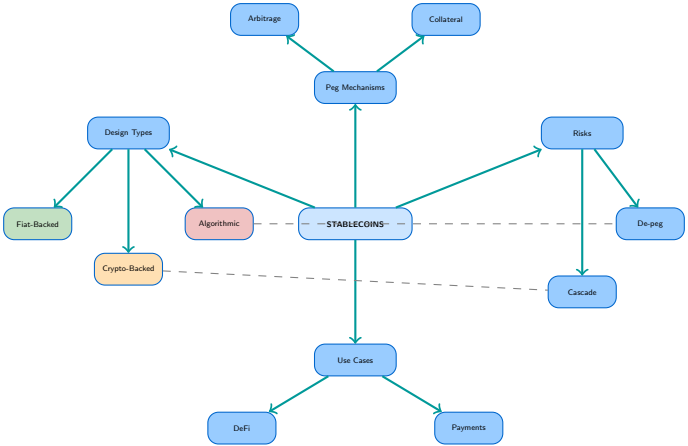
Key Takeaways from Topic 4.3

1. **Three design types** with different trade-offs
   Fiat-backed (stable, centralized), Crypto-collateralized (decentralized, inefficient), Algorithmic (efficient, risky)
2. **The Stablecoin Trilemma constrains design**
   Can only optimize two of: Decentralization, Stability, Capital Efficiency
3. **Peg mechanisms rely on arbitrage and trust**
   Without reliable redemption, pegs can break catastrophically
4. **Terra/UST proved algorithmic stability is fragile**
   Death spirals destroy value rapidly when confidence breaks
5. **Heavy regulatory scrutiny is coming**
   MiCA in EU, pending legislation in US, global coordination

The Big Idea

Stablecoins are the critical bridge between crypto and traditional finance, but each design involves fundamental trust trade-offs.

Concept Map: Stablecoin Ecosystem



Key Terms & Definitions (I)

Stablecoin A cryptocurrency designed to maintain a stable value relative to a reference asset (typically $1 USD).

Peg The target price a stablecoin aims to maintain, typically $1.00.

De-peg When a stablecoin's market price deviates significantly from its target peg.

Fiat-Backed Stablecoin A stablecoin backed 1:1 by fiat currency reserves held by a centralized issuer (e.g., USDC, USDT).

Collateralization Ratio The ratio of collateral value to debt; crypto-backed stablecoins typically require 150%+ collateralization.

Key Terms & Definitions (II)

Crypto-Collateralized Stablecoin A stablecoin backed by over-collateralized cryptocurrency locked in smart contracts (e.g., DAI).

Algorithmic Stablecoin A stablecoin that maintains its peg through algorithmic supply adjustments rather than collateral backing.

Liquidation The forced sale of collateral when a vault's collateralization ratio falls below the minimum threshold.

Death Spiral A reflexive feedback loop where falling prices trigger mechanisms that cause further price declines.

Stablecoin Trilemma The impossibility of simultaneously achieving full decentralization, perfect stability, and high capital efficiency.

Attestation An independent accounting report verifying stablecoin reserves (less rigorous than a full audit).

Common Misconceptions

Misconception	Reality
"Stablecoins are stable"	Stablecoins *target* stability but can de-peg, especially during market stress
"Fiat-backed means risk-free"	Fiat-backed coins carry counterparty, banking, and regulatory risks (see SVB crisis)
"Algorithmic = decentralized = good"	Algorithmic designs have proven fragile; decentralization alone doesn't ensure stability
"Higher yield = better stablecoin"	Unsustainable yield is often a warning sign of hidden risks (see Anchor/UST)

Critical Thinking

Always ask: What backs this stablecoin? Who can freeze it? What happens in a crisis?

Self-Assessment: Question 1

Question

Which of the following is NOT a characteristic of fiat-backed stablecoins like USDC?

A. 1:1 backing by USD or USD-equivalent reserves
B. Centralized issuer that can freeze addresses
C. Over-collateralization requirement of 150%+
D. Regular attestation reports on reserve holdings

Self-Assessment: Question 1

Question

Which of the following is NOT a characteristic of fiat-backed stablecoins like USDC?

A. 1:1 backing by USD or USD-equivalent reserves
B. Centralized issuer that can freeze addresses
C. Over-collateralization requirement of 150%+
D. Regular attestation reports on reserve holdings

Answer: C

Explanation: Fiat-backed stablecoins use 1:1 backing (100% collateralization), not over-collateralization. The 150%+ over-collateralization requirement is characteristic of *crypto-collateralized* stablecoins like DAI, which need extra buffer due to collateral volatility.

Self-Assessment: Questions 2-3

Question 2 (from Quiz)

What is the Stablecoin Trilemma?

Answer: The impossibility of simultaneously achieving **decentralization**, **stability**, and **capital efficiency**. Every stablecoin design must compromise on at least one dimension.

Question 3 (from Quiz)

Why did the Terra/UST algorithmic stablecoin collapse?

Answer: UST relied on a reflexive mint/burn mechanism with LUNA. When confidence broke, mass redemptions crashed LUNA's price, making it impossible to absorb UST selling pressure. This created a **death spiral**—a feedback loop where falling prices trigger mechanisms that cause further price declines.

Key Lesson: When the peg mechanism depends on confidence in the peg, the system is vulnerable to self-fulfilling collapse.

Preview: Tokenization of Real-World Assets

In Topic 4.4, we'll explore:

- **Real-World Asset (RWA) tokenization**—putting stocks, bonds, real estate on-chain
- **Central Bank Digital Currencies (CBDCs)**—digital government money
- **Security tokens**—regulated digital securities
- **The convergence** of traditional and decentralized finance

Connection

Topic 4.3 covered stablecoins as the first bridge between TradFi and crypto.
Topic 4.4 extends this to tokenizing *all* real-world assets.

Preparation: Consider how stablecoin mechanisms might apply to tokenized assets.

Resources for Further Learning

Essential Reading:

- MakerDAO Documentation (DAI mechanics)
- Circle USDC Transparency Reports
- Terra Post-Mortem Analysis

Online Resources:

- Course notebook: `NB10_Stablecoin_Analysis.ipynb`
- DeFiLlama Stablecoin Dashboard: `https://defillama.com/stablecoins`
- The Block: Stablecoin Reports

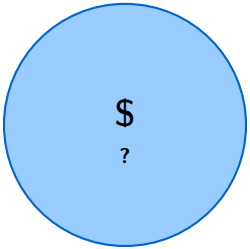
Academic References:

- Klages-Mundt et al. "Stablecoins 2.0" (DeFi stability analysis)
- BIS Reports on Stablecoins and Financial Stability

Course Materials

All slides and notebooks available on the course website.

Questions & Discussion



Stablecoins: Bridge or Risk?

Contact: joerg.osterrieder@gmail.com

Next Topic: T4.4 — Tokenization and CBDCs