Appendix to:Households Allocation of the Next Generation of Digital Money

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Contents

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1 Monetary Status of Stablecoins

Stablecoins have emerged as a critical infrastructure in digital finance, facilitating payments, serving as collateral in decentralized finance (DeFi), and offering a temporary store of value amid cryptocurrency volatility. Their market capitalization reached over $150 billion by 2024, with leading instruments such as Tether (USDT) and USD Coin (USDC) widely used across centralized and decentralized platforms. However, their design as private claims on fiat-denominated reserves introduces significant questions regarding their monetary nature, systemic stability, and interaction with sovereign monetary systems.

We seek to address whether stablecoins can be regarded as money, in the monetary-economics sense, and under what conditions they may constitute a durable form of liquidity. Drawing on empirical episodes, theoretical modeling, and institutional comparisons with CBDCs, we provide a structured framework for analyzing the monetary status of stablecoins.

Theoretical Foundations and Historical Parallels

The monetary status of a financial instrument is traditionally assessed through the functions of money: medium of exchange, unit of account, and store of value. Stablecoins exhibit partial fulfillment of these functions, particularly in their use for exchange and liquidity in digital financial markets. However, unlike fiat currency or central bank liabilities, their capacity as a store of value depends critically on reserve quality and convertibility.

The 2008 Global Financial Crisis (GFC) provides a useful analogy. Mortgage-backed securities (MBS), particularly those backed by subprime assets, appeared stable under normal conditions but proved fragile under stress due to the declining quality of underlying assets (Gorton, 2010). Similarly, stablecoins backed by bank deposits or short-term commercial paper (as in early USDT structures) exhibit latent run risk, as demonstrated during the TerraUSD collapse in 2022 (Fiedler et al., 2023).

Case-studies on Stablecoin Fragility

We analyze several empirical episodes:

- **TerraUSD (2022):** An algorithmic stablecoin pegged to the U.S. dollar through a mint-burn mechanism with LUNA. Its collapse erased over $40 billion in market value and triggered regulatory scrutiny worldwide.
- **Tether (USDT) Transparency Concerns (2021–2022):** Repeated delays in auditing reserve composition and reliance on less-liquid assets created persistent doubts about solvency. Although Tether has since shifted towards more conservative holdings (primarily T-bills), the episode illustrated the importance of credible reserve disclosures.
- **USD Coin (USDC) Depeg (2023):** Temporary depegging following exposure to Silicon Valley Bank highlighted the interconnectedness of stablecoins and traditional banking failures.

These cases reveal that stablecoins, while often behaving like money in day-to-day use, are exposed to credit, liquidity, and operational risks not typically associated with sovereign currency.

A Macro-Financial Model of Stablecoin Stability

The endogenous stability of stablecoins can be represented with a plain-vanilla stylized macro-financial model. Let stablecoin supply S_t be backed by reserves R_t, consisting of short-term sovereign debt and bank deposits. Let ϑ denote the proportion of high-quality liquid assets (HQLA) in R_t, and λ_t denote the redemption pressure as a function of macroeconomic stress y_t:

$$S_t = \vartheta R_t - \lambda_t(y_t) \tag{1}$$

Stability requires:

$$\frac{\partial \lambda_t}{\partial y_t} > \frac{\partial(\vartheta R_t)}{\partial y_t} \Rightarrow \text{fragility under stress.}$$

We simulate the model under shocks to y_t (e.g., interest rate volatility, fiscal stress) and show that low ϑ and high redemption elasticity result in nonlinear collapse probabilities. Calibration using data from the Terra and USDC episodes corroborates the model's predictions. Figure 1 represents the simulation of Matlab script in Listing 1 of Appendix 1.2, for the assumptions see there.

The plot illustrates how the probability of a stablecoin collapse responds nonlinearly to macroeconomic stress, depending on two key parameters:

- Reserve quality ϑ: A lower share of high-quality reserves (e.g., short-term government debt) increases fragility.
- Redemption elasticity ζ: A higher elasticity (greater sensitivity of redemptions to stress) exacerbates instability.

Empirically, the TerraUSD collapse corresponds to a scenario with high redemption elasticity, high-ζ, and effectively zero reserve quality (algorithmic backing), low-ϑ, explaining its sharp collapse. In contrast, USDC's depeg resembled a high-ϑ, lower-ζ situation—temporary stress without structural insolvency.

This simulation confirms that nonlinear collapse probabilities emerge endogenously when redemption pressure responds strongly to macroeconomic volatility, especially when reserve structures are weak.

Are they Money?

In contrast to stablecoins, CBDCs are direct liabilities of central banks and thus not susceptible to the reserve fragilities of stablecoins. They offer finality in settlement, legal tender status, and integration into the existing monetary policy framework (BIS, 2021; Carapella et al., 2024; Bouis et al., 2024; Ahner et al., 2024).

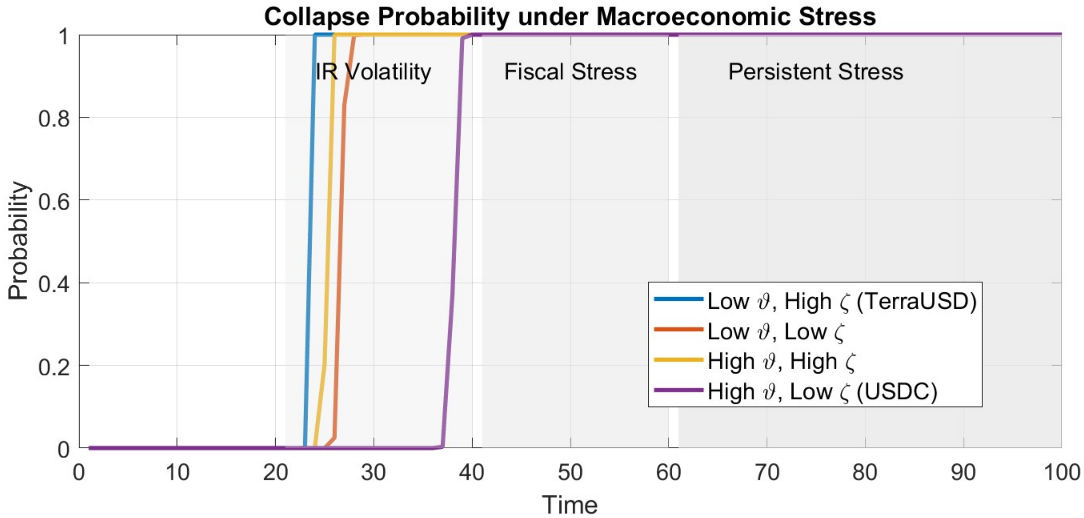

Figure 1: Probability of Stablecoin collapse under phases of shock: interest rate volatility, fiscal stress and persistent stress, following equation 1.

From a monetary hierarchy perspective (Mehrling, 2012), CBDCs sit at the top layer as state money, while stablecoins occupy a lower tier, contingent on convertibility and reserve credibility. This hierarchy has implications for monetary sovereignty, particularly in emerging markets where dollar-based stablecoins could displace local currency usage (Adrian and Mancini-Griffoli, 2019).

Stablecoins present a dual-edged innovation: they enhance payment efficiency and financial inclusion but simultaneously introduce new forms of systemic risk. Regulatory regimes must enforce high standards of reserve transparency, redemption rights, and risk management.

CBDCs provide a structurally sound alternative, offering the benefits of digital money without the fragility inherent in private collateral structures. However, their deployment raises questions about privacy, disintermediation, and technological capacity. As emphasized by Panetta (2025), the design of CBDC must ensure resilience against private digital money proliferation while safeguarding monetary sovereignty and financial stability.

In conclusion, stablecoins may fulfill quasi-monetary roles in the digital economy, but their long-term viability as money depends on reserve integrity and macroeconomic stability. By contrast, CBDCs represent a more robust framework for digital public money, aligning with central bank mandates and systemic stability objectives.

BIS (2025) outlines a vision for a next-generation monetary and financial system underpinned by tokenisation and programmable infrastructures. At its core is the proposal of a *unified ledger*, integrating tokenised central bank reserves, commercial bank money, and financial assets to enable atomic settlement and new forms of financial automation. BIS (2025) evaluates digital money using three key criteria: *singleness*, *elasticity*, and *integrity*. While stablecoins offer programmability and access to digital financial ecosystems, they consistently fall short on all three fronts: they trade at variable rates (undermining singleness), lack on-demand issuance mechanisms (undermining elasticity), and are prone to illicit use due to insufficient compliance standards (compromising integrity). Consequently, they are deemed unsuitable as core components of the monetary system.

Finally BIS (2025) advocates for a central bank-led transformation, preserving the trust-based, two-tier structure of modern finance, based on central bank and commercial banks. Tokenisation is seen not as a disruptive replacement but as an evolutionary tool that can enhance efficiency, transparency, and functionality—particularly in cross-border payments and securities settlement. All in all, regulatory clarity, international coordination, and public-private collaboration could ensure that innovation supports financial stability and monetary sovereignty.

Similarities between Stablecoins and Shadow Banking

The growing resemblance of certain stablecoin designs to money market funds (MMFs) or short-term deposit instruments has revived longstanding concerns associated with the shadow banking system. In particular, stablecoins that promise redemption at par, are backed by short-duration liquid assets (e.g., T-bills, reverse repos), and circulate as near-money in digital transactions may effectively perform the economic role of deposit substitutes—without being subject to equivalent prudential regulation, liquidity requirements, or central bank access.

The functional parallels with MMFs are especially striking. Both MMFs and fiat-referenced stablecoins aim to preserve a stable value relative to a fiat currency, offer immediate liquidity to holders, and invest in high-quality short-term assets. However, while MMFs are regulated under comprehensive frameworks (such as Regulation (EU) 2017/1131 in the EU and Rule 2a-7 in the U.S.), stablecoins often operate in a fragmented or lightly supervised legal environment. MMFs are subject to portfolio diversification rules, liquidity buffers, and redemption gates to manage run risk. In contrast, many stablecoins lack formal redemption guarantees, transparent reserve disclosures, or standardized stress-testing requirements.

These features draw stablecoins conceptually closer to the pre-crisis forms of shadow banking: entities that issue liabilities resembling money (e.g., repo contracts, asset-backed commercial paper), hold liquid reserves, and promise short-term convertibility—yet exist outside the traditional bank-regulatory perimeter. As in the case of shadow banking, the absence of backstops or robust supervision increases the risk of sudden redemptions, reserve mismanagement, and financial contagion. The possibility that stablecoins could grow to intermediate a significant volume of retail payments or even savings behavior amplifies these concerns.

These structural similarities have led many observers to classify certain stablecoin arrangements as a modern form of "shadow money."[1] As regulators seek to balance innovation with monetary stability, a key challenge lies in determining whether stablecoins should be treated as payment instruments, investment funds, or synthetic deposits—and whether they warrant regulation analogous to that applied to MMFs or bank liabilities.

[1]See, for instance, Gorton and Metrick (2012) on the parallels between repo-backed shadow banking and money substitutes, and more recently, discussions by the Financial Stability Board (2020) and Bank for International Settlements (2021) on the potential systemic impact of stablecoins and their resemblance to shadow money.

Why Credit Card Networks and Platforms May Issue Stablecoins

In addition to fintechs and non-bank financial institutions, both credit card networks (e.g., Visa, Mastercard) and large digital platforms (e.g., PayPal, Amazon, Meta) have clear economic and strategic incentives to issue stablecoins. These entities operate at the intersection of digital payments, consumer finance, and online commerce, and face increasing competition from token-based infrastructures that promise instant settlement, programmability, and global interoperability.

For credit card networks, issuing a regulated stablecoin represents a forward-looking response to the structural inefficiencies of legacy card rails. Stablecoin settlement can reduce interchange fees, eliminate chargeback risks, and support low-value, high-frequency transactions such as micropayments or in-app purchases. Moreover, card networks already possess compliance infrastructure (AML/KYC) and regulatory credibility, which positions them well to issue fiat-referenced tokens within forthcoming legal frameworks. In the model, such stablecoins would offer high convenience yields (θ_j) due to their broad merchant acceptance, brand trust, and integration with existing wallets and APIs.

For digital platforms, stablecoin issuance extends the logic of closed-loop balances into transferable, programmable instruments. A platform-issued stablecoin may combine high liquidity with seamless integration into proprietary ecosystems—allowing users to spend, earn, and redeem value across shopping, streaming, messaging, and financial services. These tokens can also enhance user retention through reward programs or embedded financial features. From a balance sheet perspective, platform-issued stablecoins may resemble synthetic liabilities backed by cash, securities, or custodial bank deposits, similar to existing stablecoins but with broader ecosystem utility.

In both cases, stablecoin issuance serves not only as a payments innovation but as a form of strategic control over the user interface of digital finance. In equilibrium, these instruments compete with traditional money-like assets on the basis of convenience-adjusted returns. If θ_j is sufficiently high due to integration, usability, or incentives, households may reallocate wealth toward these instruments—even in the absence of explicit interest payments.

1.1 Matlab script

1.2 Assumptions of Figure 1 and Listing 1: Stablecoin Collapse

The simulation in Listing 1 models the probability of stablecoin collapse under different macroeconomic stress scenarios. The following assumptions underpin the model:

1. **Time Horizon:** The simulation spans $T = 100$ periods, representing a stylized timeline of macroeconomic developments.

2. **Macroeconomic Stress (y_t):** The model introduces exogenous shocks to the economy through a stress variable y_t, which evolves in three phases:

   - Periods 1–20: Random noise (normal conditions).
   - Periods 21–40: Gradual increase in stress (e.g., interest rate volatility).
   - Periods 41–60: Escalating fiscal stress.

- Periods 61–100: Persistent high stress.

3. **Reserve Quality (ϑ):** Two levels of reserve quality are considered:

   - Low quality: $\vartheta = 0.3$
   - High quality: $\vartheta = 0.9$

   This parameter reflects the share of high-quality liquid assets (HQLA) in the stablecoin's backing reserves.

4. **Redemption Pressure (λ_t):** Redemption demand is modeled as a nonlinear function of macroeconomic stress:

$$\lambda_t = \alpha \cdot x_t^{\zeta}$$

   where α and ζ are parameters capturing the intensity and elasticity of redemptions. Two configurations are tested:

   - High elasticity: $(\alpha = 20, \zeta = 2)$
   - Low elasticity: $(\alpha = 10, \zeta = 1)$

5. **Stablecoin Supply (S_t):** The effective backing of stablecoins is given by:

$$S_t = \vartheta R_t - \lambda_t$$

   where $R_t = 100$ is the nominal reserve level. This equation captures the idea that redemptions reduce the effective backing of stablecoins.

6. **Collapse Probability:** The probability of collapse is modeled using a logistic function:

$$\text{collapse\_prob}_t = \frac{1}{1 + \exp(S_t)}$$

   This ensures that as S_t becomes negative (i.e., redemptions exceed reserves), the probability of collapse approaches 1.

7. **Scenarios:** The simulation evaluates four combinations of (ϑ, ζ) to illustrate how reserve quality and redemption elasticity jointly affect collapse risk.

Matlab script: Probability of Stablecoin collapse - Figure 1

```
% model_simulation.m
T = 100; % time horizon
x_shock = randn(T, 1).*.1;
x_shock(21:40) = linspace(0, 10, 20); % interest rate volatility shock
x_shock(41:60) = linspace(10, 20, 20); % fiscal stress
x_shock(61:end) = 20; % persistent stress

R_t = 100; % nominal reserves
theta_vals = [0.3, 0.9]; % low and high reserve quality
alpha_beta_vals = [20, 2; 10, 1]; % high and low redemption elasticity
```

```

collapse_probs = zeros(T, 4);

for i = 1:2
    theta = theta_vals(i);
    for j = 1:2
        alpha = alpha_beta_vals(j, 1);
        beta = alpha_beta_vals(j, 2);
        lambda_t = alpha * x_shock.^beta; % Demand for redemption, dependent on shock
        S_t = theta * R_t - lambda_t;     % Reserve coverage (theta*R_t) minus redemption demand (lambda_t)
        collapse_prob = 1 ./ (1 + exp(S_t)); % logistic function for collapse probability
        collapse_probs(:, 2*(i-1)+j) = collapse_prob;
    end
end
```

Listing 1: Probability of Stablecoin collapse under phases of shock - Figure 1

2 Simulation

To illustrate the model's implications, we simulate a simple numerical example in which households allocate their financial wealth across CBDC, stablecoins, and bank deposits based on their respective *convenience-adjusted returns*:

$$r_j = i_j + \theta_j, \quad j \in \{c, S, D\}.$$

The simulation assumes that households distribute their portfolio shares using a softmax function, which ensures strictly positive and normalized weights:

$$\eta_j = \frac{e^{r_j}}{e^{r_c} + e^{r_S} + e^{r_D}}.$$

This functional form captures imperfect substitution and bounded reallocation elasticity, and reflects the intuition that households increasingly favor the asset offering the highest convenience-adjusted return, without immediately abandoning the others.

We fix the convenience yield of bank deposits at $\theta_D = 0.03$, and explore how changes in the convenience yields of CBDC (θ_c) and stablecoins (θ_S) affect equilibrium portfolio shares. We assume CBDC pays zero interest ($i_c = 0$), and that stablecoins incur a platform fee f_S, yielding $i_S = r^* - f_S$ with $r^* = 0.02$ and $f_S = 0.015$. Deposits earn a market-determined rate i_D set to ensure convenience-adjusted return parity, but held constant in the simulation for simplicity. The results are shown in Figure 2 – representing the simulation of Matlab script in Listing 2 in Appendix 2.1, for the assumptions see there.

The plots show how tipping points in portfolio allocation emerge: when the convenience-adjusted return of one instrument becomes marginally more attractive than the others, households reallocate abruptly. This nonlinear sensitivity underscores the strategic role of design features (e.g., programmability, privacy, integration) in shaping digital money

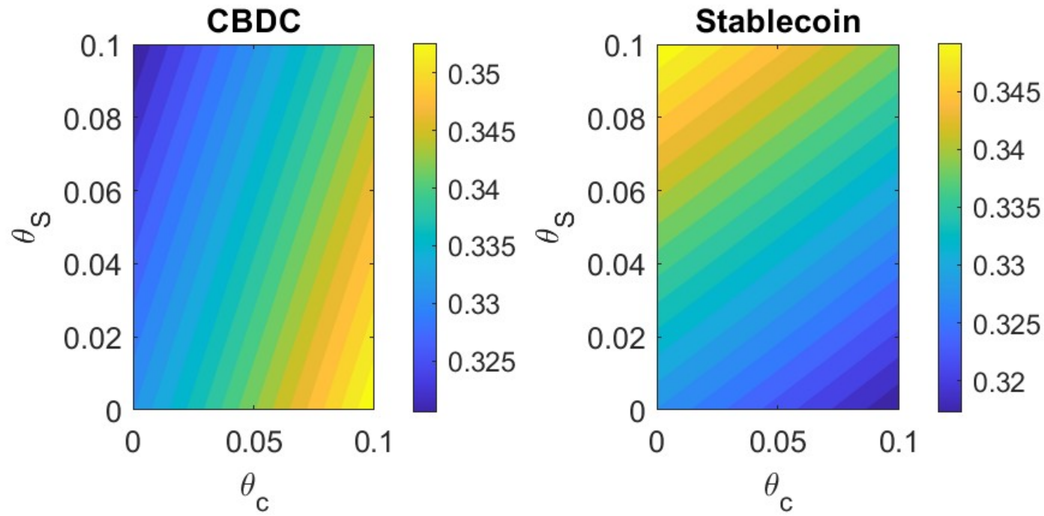

Figure 2: Equilibrium shares of CBDC and stablecoins as functions of their respective convenience yields, θ_c and θ_S. The left panel shows CBDC share increasing in θ_c and decreasing in θ_S. The right panel shows the mirror behavior for stablecoins. Even modest changes in convenience yield can induce large shifts in household portfolios.

adoption.

The simulation abstracts from general equilibrium feedback effects—such as interest rate responses, lending constraints, or bank behavior—but captures the essential mechanism: households equalize convenience-adjusted returns and tilt their portfolio toward the most attractive instruments. The framework provides a tractable tool for studying monetary design and competition in a digital environment.

2.1 Assumptions of Figure 2 and Listing 2: Portfolio Allocation

Listing 2 presents a numerical simulation of household portfolio allocation among three monetary instruments: central bank digital currency (CBDC), stablecoins, and bank deposits. The simulation is based on the concept of *convenience-adjusted returns*, which combine financial yields with nonpecuniary benefits. The following assumptions are made:

1. **Convenience-Adjusted Return:** For each instrument $j \in \{c, S, D\}$ (CBDC, stablecoin, deposit), the return is defined as:

$$r_j = i_j + \theta_j$$

   where i_j is the financial yield and θ_j is the convenience yield.

2. **Softmax Allocation Rule:** Households allocate their wealth across instruments using a softmax function, which ensures that all shares are positive and sum to one:

$$\eta_j = \frac{e^{r_j}}{e^{r_c} + e^{r_S} + e^{r_D}}$$

This reflects the idea that households probabilistically favor instruments with higher convenience-adjusted returns.

3. **Fixed Parameters:**
   - Policy rate: $r^* = 0.02$
   - Deposit rate: $i_D = r^* - 0.005 = 0.015$
   - Stablecoin fee: $f_S = 0.01$, so $i_S = r^* - f_S = 0.01$
   - Deposit convenience yield: $\theta_D = 0.03$ (fixed)

4. **Convenience Yield Ranges:**
   - CBDC convenience yield θ_c varies from 0 to 0.1
   - Stablecoin convenience yield θ_S varies from 0 to 0.1

   These ranges are used to explore how changes in perceived convenience affect portfolio shares.

5. **Grid Simulation:** The simulation evaluates $n = 50$ values for each of θ_c and θ_S, resulting in a 50×50 grid of scenarios.

6. **Output:** For each (θ_c, θ_S) pair, the model computes the share of household wealth allocated to:
   - CBDC
   - Stablecoins
   - Bank deposits

   These shares are stored and visualized to identify tipping points in portfolio preferences.

Matlab script: model simulation - Figure 2

```
%% model_simulation.m: CBDC, Stablecoins, and Bank Deposits
clear; clc; close all;

%% Parameters
n = 50; % Number of points for convenience yield grids
r_star = 0.02; % Base policy rate (CBDC & reserves)
iD = r_star - 0.005; % deposit rate slightly below CBDC
fS = 0.01; % stablecoin fee (so iS = r_star - fS)

% Ranges of convenience yields
theta_c_range = linspace(0, 0.1, n); % CBDC convenience yield
theta_s_range = linspace(0, 0.1, n); % Stablecoin convenience yield

[ThetaC, ThetaS] = meshgrid(theta_c_range, theta_s_range);

%% Output storage
```

```
CBDC_share = zeros(n, n);
Stablecoin_share = zeros(n, n);
Deposit_share = zeros(n, n);

%% Loop over grid of (theta_c, theta_s) combinations
for i = 1:n
    for j = 1:n
        theta_c = ThetaC(j,i); % meshgrid ordering: rows by y-axis
        theta_s = ThetaS(j,i);
        theta_d = 0.03; % fixed deposit convenience

        Rc = r_star + theta_c;
        Rd = iD + theta_d;
        iS = r_star - fS;
        Rs = iS + theta_s;

        % Softmax allocation (exponential to reflect preference
            sensitivity)
        expRc = exp(Rc);
        expRd = exp(Rd);
        expRs = exp(Rs);
        total_exp = expRc + expRd + expRs;

        shareC = expRc / total_exp;
        shareD = expRd / total_exp;
        shareS = expRs / total_exp;

        % Store shares
        CBDC_share(j,i) = shareC;
        Deposit_share(j,i) = shareD;
        Stablecoin_share(j,i) = shareS;
    end
end
```

Listing 2: Equilibrium shares as functions of their convenience yields - Figure 2

3 Network Effects and Endogenous Convenience Yields

We extend the baseline model by allowing the convenience yields of CBDC and stablecoins to depend endogenously on their respective adoption levels, capturing network externalities and infrastructure investment. Specifically, let θ_c and θ_S be increasing functions of aggregate holdings M_c and S, respectively. This setup introduces the possibility of multiple equilibria or "money wars" between the central bank and non-financial intermediaries (NFIs).

We model convenience yields as saturating nonlinear functions:

$$\theta_c(\nu_c) = \theta_{c0} + \frac{a_c \nu_c^2}{1+\nu_c^2},$$

$$\theta_S(\nu_S) = \theta_{S0} + \frac{a_S \nu_S^2}{1+\nu_S^2},$$

where $\nu_c = M_c$, $\nu_S = S$ are the network effect parameters, θ_{c0}, θ_{S0} are base convenience yields, and a_c, a_S are scaling coefficients.

Households allocate wealth across CBDC, stablecoins, and deposits to equalize convenience-adjusted returns:

$$
\begin{aligned}
i_c + \theta_c(\nu_c) &= i_D + \theta_D, \\
i_S + \theta_S(\nu_S) &= i_D + \theta_D, \\
M_c + D + S &= W = 1.
\end{aligned}
$$

We assume households use a softmax allocation rule to determine portfolio shares:

$$
\eta_j = \frac{e^{r_j}}{e^{r_c} + e^{r_S} + e^{r_D}}, \quad \text{for } j \in \{c, S, D\},
$$

where $r_j = i_j + \theta_j$ is the convenience-adjusted return of asset j.

Figure 3 illustrates how nonlinear network effects influence household preferences and the equilibrium composition of money-like instruments. When ν_S is large, stablecoins benefit from stronger network externalities and may dominate household portfolios. Conversely, improvements in CBDC usability—such as enhanced privacy, interoperability, or user experience—that raise ν_c can shift the equilibrium toward CBDC. The model captures tipping points: small changes in convenience parameters can lead to abrupt reallocations in household portfolios.

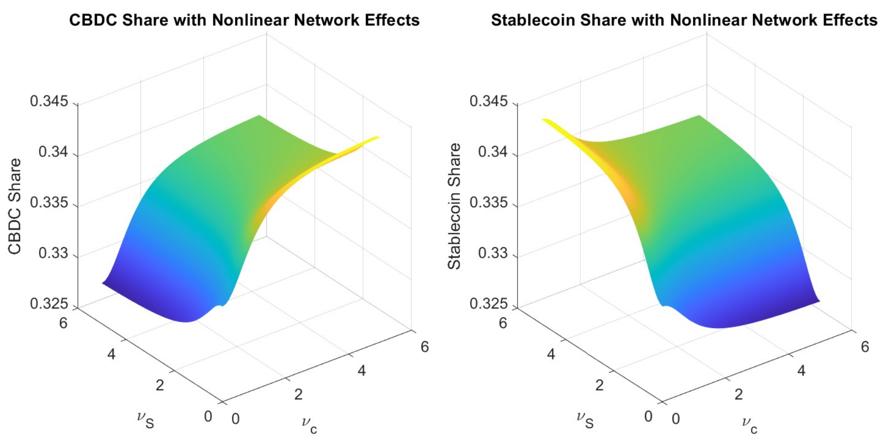

Figure 3: Equilibrium shares of CBDC and stablecoins as functions of their respective network effect parameters, ν_c and ν_S.

3.1 Assumptions of Figure 3 and Listing 3: Nonlinear Network Effects

Listing 3 presents a simulation of household portfolio allocation across CBDC, stablecoins, and bank deposits, incorporating nonlinear network effects. The model assumes that the convenience yield of digital instruments increases with their adoption, capturing feedback loops in user preferences. The key assumptions are:

1. **Convenience-Adjusted Return:** For each instrument $j \in \{c, S, D\}$ (CBDC, stablecoin, deposit), the return is defined as:

   $$r_j = i_j + \theta_j(\nu_j)$$

   where i_j is the financial yield and $\theta_j(\nu_j)$ is the convenience yield, which depends on a network effect parameter ν_j.

2. **Network Effects:** The convenience yields for CBDC and stablecoins are modeled as nonlinear, saturating functions of their respective network parameters:

   $$\theta_c(\nu_c) = \theta_{c0} + \frac{a_c \cdot \nu_c^2}{1 + \nu_c^2}, \quad \theta_S(\nu_S) = \theta_{S0} + \frac{a_S \cdot \nu_S^2}{1 + \nu_S^2}$$

   where θ_{c0} and θ_{S0} are base convenience yields, and a_c, a_S are scaling parameters.

3. **Fixed Financial Returns:**

   - Policy rate: $r^* = 0.02$
   - Deposit rate: $i_D = r^* - 0.005 = 0.015$
   - Stablecoin fee: $f_S = 0.01$, so $i_S = r^* - f_S = 0.01$
   - Deposit convenience yield: $\theta_D = 0.03$ (fixed)

4. **Softmax Allocation Rule:** Households allocate wealth using a softmax function:

   $$\eta_j = \frac{e^{R_j}}{e^{R_c} + e^{R_s} + e^{R_d}}$$

   This ensures that all shares are positive and sum to one, reflecting probabilistic preferences.

5. **Simulation Grid:** The simulation evaluates a 50×50 grid of values for ν_c and ν_S, each ranging from 0 to 5, to explore how network effects influence portfolio shares.

6. **Output:** For each (ν_c, ν_S) pair, the model computes the share of household wealth allocated to:

   - CBDC
   - Stablecoins
   - Bank deposits

   These shares are visualized to identify tipping points and dominance regions in digital money adoption.

Matlab script: Nonlinear Network Effects – Figure 3

```matlab
% Nonlinear Network Effects on CBDC and Stablecoin Shares
clear; clc;

% Parameter ranges
nu_c_vals = linspace(0, 5, 50);
nu_s_vals = linspace(0, 5, 50);
[Nu_c, Nu_s] = meshgrid(nu_c_vals, nu_s_vals);

% Fixed parameters
r_star = 0.02;        % baseline interest rate
theta_c0 = 0.01;      % base convenience yield for CBDC
theta_s0 = 0.01;      % base convenience yield for stablecoin

% Nonlinear network effect functions (e.g., logistic or quadratic)
nonlinear_theta_c = @(nu_c) theta_c0 + 0.05 * nu_c.^2 ./ (1 + nu_c.^2);  % saturating
nonlinear_theta_s = @(nu_s) theta_s0 + 0.05 * nu_s.^2 ./ (1 + nu_s.^2);  % saturating

% Compute convenience-adjusted returns
theta_c = nonlinear_theta_c(Nu_c);
theta_s = nonlinear_theta_s(Nu_s);
ret_cbdc = r_star + theta_c;
ret_stable = r_star + theta_s;
ret_deposit = r_star; % fixed return for deposits

% Softmax allocation
exp_c = exp(ret_cbdc);
exp_s = exp(ret_stable);
exp_d = exp(ret_deposit);
total = exp_c + exp_s + exp_d;

share_cbdc = exp_c ./ total;
share_stable = exp_s ./ total;

% Plot CBDC share
% figure;
subplot(1,2,1)
surf(Nu_c, Nu_s, share_cbdc);
xlabel('\nu_c');
ylabel('\nu_S');
zlabel('CBDC Share');
title('CBDC Share with Nonlinear Network Effects');
shading interp;
set(gca,'Fontsize',12)

% Plot Stablecoin share
subplot(1,2,2)
surf(Nu_c, Nu_s, share_stable);
xlabel('\nu_c');
ylabel('\nu_S');
zlabel('Stablecoin Share');
```

```
title('Stablecoin Share with Nonlinear Network Effects');
shading interp;
set(gca,'Fontsize',12)
```

Listing 3: Nonlinear Network Effects on CBDC and Stablecoin Shares – Figure 3

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