Stablecoins: Adoption and Fragility

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[1] The views expressed in this presentation are solely the responsibility of the author and should not be interpreted as reflecting the views of the Riksbank.

Motivation

Stablecoins are getting a lot of attention after the Facebook Libra wake-up call and amid the rapid development of crypto markets

- What are the reasons behind the fragility of stablecoins and what factors contribute to their fragility?
- Can stablecoin adoption be excessive?
- How should stablecoins be regulated?

This Paper

Objective: Develop a theoretical model of stablecoins that allows to analyze the determinants of adoption and fragility

- Contrast the beneficial role of stablecoins with the risk of stablecoin runs and downsides from wider adoption
- Shed light on prominent features of the stablecoins market
- Gain insights for the risk assessment and regulation

Summary - Model in a Nutshell and Place in the Literature

Two period model

- **Interim date:** stablecoin conversion game
  - Global game of regime change (Carlsson and van Damme 1993)
- **Ex-ante date:** stablecoin adoption game
  - **Premise:** stablecoins offer a *benefit* for certain use cases and the potential holders are *heterogeneous* in how much they benefit from different means of payment (Agur et al. 2022)
  - Consumers trade off the benefits of stablecoins with the return differential relative to deposits and the risk of devaluation

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Relation to the literature Literature

- Diamond-Dybvig: adoption game endogenizes the liability side
- Focus on payment aspect and study determinants of adoption and fragility with a view on risk assessment and regulation

Summary - Main Results

- Identify two mechanisms that can justify the regulatory community's concern about excessive stablecoin adoption
    1. Uninternalized destabilizing composition effect
    2. Uninternalized network effects, which can undermine the role of bank deposits as a means of payment
- Fragility
    - Factors that promote stablecoin adoption also tend to make the marginal coin holder less flighty $\rightarrow$ less runs
    - Factors that increase the issuer's revenue from fees and seigniorage promote stability, as do congestion effects
- Support for a regulatory disclosure regime and rules on reserves and the capitalization of issuers

The Model

Environment and Agents

- Three dates ($t = 0, 1, 2$) and a unit continuum of risk-neutral consumers $i \in [0, 1]$, endowed with \$1, who consume at $t = 2$

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- Deposits are modeled as an "outside option" with an exogenous interest rate $r^D \geq 0$ when held from $t = 0$ to $t = 2$
- Stablecoins are issued by a monopolistic issuer
  - The issuer offers to convert cash into a digital token and vice versa one-to-one at $t = 0, 1, 2$; but may not keep her promise
  - Funds collected at $t = 0$ are invested in a risky technology with a $t = 2$ return $\theta \sim U[\underline{\theta}, \overline{\theta}]$, where $0 < \underline{\theta} < 1 < \overline{\theta}$ ▸ Tether

Environment and Agents (Continued)

- Stablecoins demand: payment preference & conversion costs
  - Consumers face idiosyncratic risk about their consumption preference at $t = 2$ and sellers have a **payment preference**

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  - G groups indexed by $g \in \{1, ..., G\}$, with $\Sigma_{g=1}^{G} m_g = 1$

payment type	probability
stablecoins	$\alpha_g = \alpha + \gamma_g$
bank deposits	$\beta_g = \beta - \gamma_g$
both	$1 - \alpha_g - \beta_g$

    - $\gamma_{g+1} > \gamma_g$: higher group numbers have a higher expected need for stablecoins at $t = 2$

Timeline

t=0 Adoption game: Stablecoins vs. insured deposits

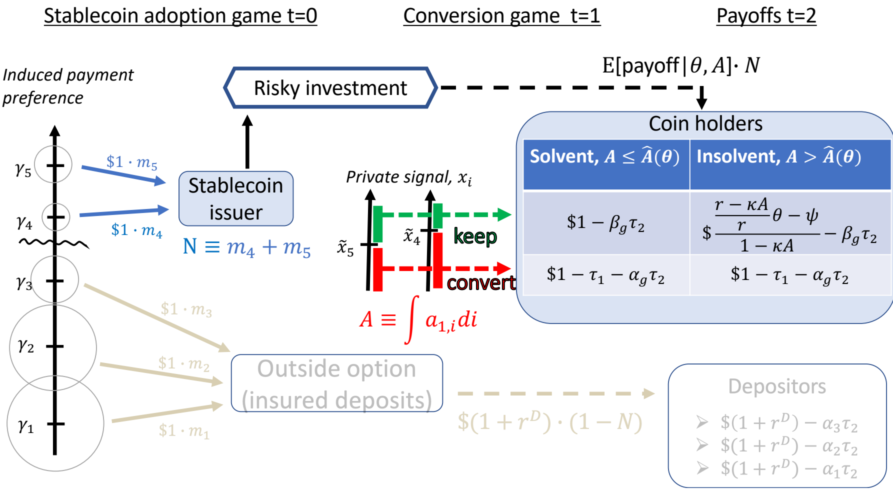
- Consumers make adoption decisions simultaneously

t=1 Conversion game: GG of regime change (Rochet and Vives 2004; Sákovics and Steiner 2009)

- Incomplete information: Active coin holders receive a private signal $x_i = \theta + \epsilon_i$ with $\epsilon_i \sim U[-\sigma\epsilon, +\sigma\epsilon]$ and $\sigma, \epsilon > 0$, and simultaneously decide whether to demand conversion at $t = 1$
- Premature divestment yields $r \leq \underline{\theta}$; bankruptcy cost $\psi \geq 0$

▶ **A1:** Coin holders are active with prob. $\kappa \in [0, r) \Rightarrow$ no rationing at $t = 1$ (Chen, Goldstein, and Jiang, 2010) Details

Graphical Illustration and Conversion Game Payoffs



Analysis and Results

Continuation EQ at $t = 1$ and Determinants of Fragility

Given Assumption 1, $\sigma \to 0$ and $N > 0$, there exists a *unique threshold equilibrium*; the issuer faces a run at $t = 1$ for all $\theta < \theta^*$:

$$\int_{\frac{(\theta^*-1)r}{\kappa(\theta^*-r)}}^{1} \left(1 - \frac{\frac{r-\kappa A}{r}\theta^* - \psi}{1-\kappa A}\right) dA = [\alpha - \beta + 2\overline{\gamma}(N)]\tau_2 + \tau_1,$$

where $\overline{\gamma}(N)$ reflects the weighted average of the payment type

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Increase in	$Prob\{\theta < \theta^*\}$
Bankruptcy cost, ψ	$\uparrow$
Fraction of active coin holders, κ	$\uparrow$
Liquidation value, r	$\downarrow$
Conversion cost, τ_1	$\downarrow$
Average relative preference for stablecoin payments, $\overline{\gamma}$	$\downarrow$

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$\Rightarrow$ *Destabilizing composition effect:*

$d\theta^* / dN > 0$ iff $d[\alpha - \beta + 2\overline{\gamma}(N))] / dN < 0$ *(Prop. 2+3, Cor. 1)*

Stablecoin Adoption at $t = 0$

The group-specific benefit from stablecoin adoption is given by:

$$\Delta_{0,i}(\overbrace{\gamma_{g_i}}^{+}, \overbrace{r^D}^{-}, \overbrace{\theta^*}^{-})$$
$$\equiv \int_{\underline{\theta}}^{\theta^*} \left(\kappa(1-\tau_1-\alpha_{g_i}\tau_2) + (1-\kappa)\left(\frac{\frac{r-\kappa}{r}\theta - \psi}{1-\kappa} - \beta_{g_i}\tau_2 \right) \right) \frac{d\theta}{\overline{\theta}-\underline{\theta}}$$
$$+ \int_{\theta^*}^{\overline{\theta}} (1-\beta_{g_i}\tau_2) \frac{d\theta}{\overline{\theta}-\underline{\theta}} - (1+r^D-\alpha_{g_i}\tau_2)$$

$\Rightarrow$ *Fragility & adoption:* A belief about a higher probability of runs is associated with lower adoption: $dN/d\theta^* \leq 0$ *(Lem. 1)*

Equilibrium: Suppose coin holders follow *threshold strategies* in the conversion game. Given Assumption 1 and $\sigma \to 0$, there exists a *unique equilibrium* of the adoption game. *(Prop. 4)*

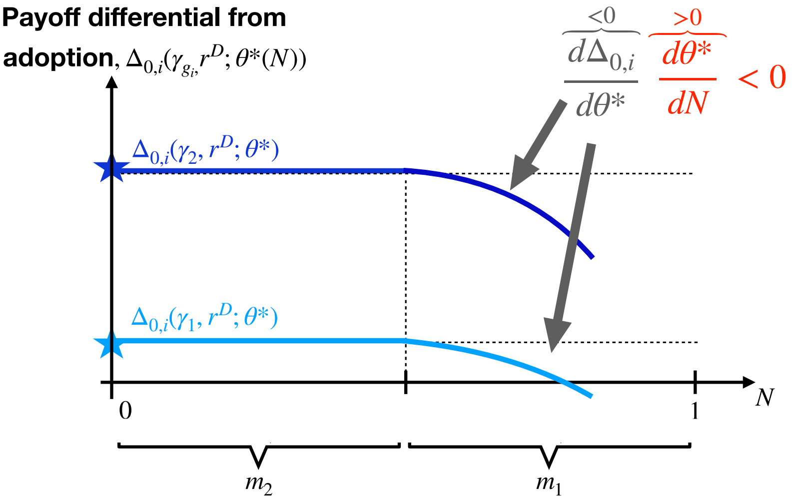
Excessive Adoption of Stablecoins

Regulators are concerned about widespread stablecoin adoption; through the lens of the model there are two relevant externalities:

1. **Uninternalized destabilizing composition effect:** A wider adoption for other stablecoin use cases can be destablizing if the new adopters are more flighty **(Tether scenario)**

2. **Uninternalized erosion of bank deposits:** With positive network effects a wider adoption can undercut the value of bank deposits for payments **(Facebook Libra scenario)**

Uninternalized Destabilizing Composition Effect: $G = 2$



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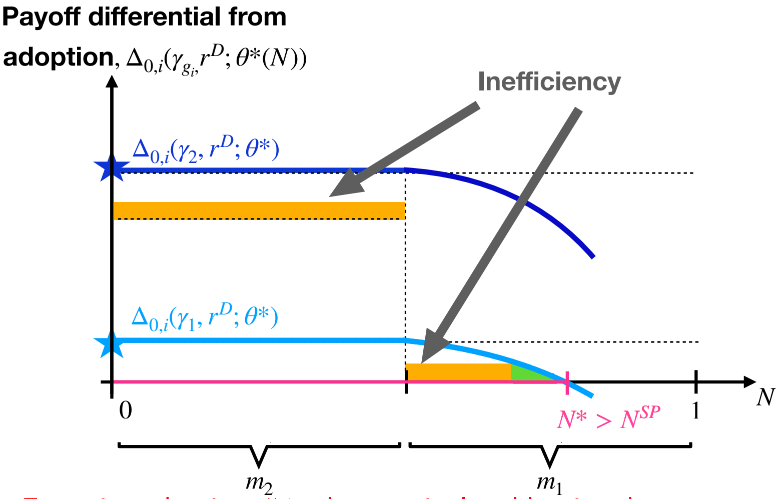

- Excessive adoption #1: the marginal stablecoin adopter poses a *negative externality* on *other coin holders* *(Prop. 5)*

Positive Network Effects

Robustness

- Introducing positive network effects can overturn the destabilizing composition effect: $\alpha'(N) > 0$ or $\beta'(1-N) > 0$

$$\Rightarrow \frac{d(\alpha(N) - \beta(1-N) + 2\overline{\gamma}(N))}{dN} > 0 \;\Leftrightarrow\; d\theta^*/dN < 0 \text{ is possible}$$

- **Caveats:**
  - With positive network effects multiple equilibria of the adoption game can co-exist
  - The origin of the positive network effect matters

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Externality #2: Uninternalized erosion of bank deposits

- Suppose a wider adoption of stablecoins reduces the probability that deposits are accepted, i.e. $\alpha'(N) > 0$, $\beta'(1-N) = 0$
- Excessive adoption #2: the marginal stablecoin adopter poses a *negative externality* on *depositors* *(Prop. 6)*

Extensions

List of Extensions

- **Moral hazard problem of the issuer and disclosure**
- **Stablecoin lending**
- Congestion effects: endogenous conversion cost at $t = 1$
- Resilience of the issuer: fixed costs of operation and transaction fee income, monetary policy
- E-money providers, narrow banks and hybrid CBDC

Discussion of Extensions

- **Moral hazard:** Low-risk vs. high-risk portfolio choice (mean-preserving spread in the distribution of θs & $r \downarrow$)
  - **Socially optimal:** Low-risk portfolio choice
  - **Transparency:** A regulatory disclosure regime *can* help to implement the efficient risk choice
  - **Caveat:** Whether the issuer implements the low-risk portfolio choice under transparency depends on the sensitivity of θ^*, N^* $\rightarrow$ Implications for skin in the game / regulation of reserves

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  - **Caveat:** Whether the issuer implements the low-risk portfolio choice under transparency depends on the sensitivity of θ^*, N^* $\rightarrow$ Implications for skin in the game / regulation of reserves
- **Stablecoin lending:** Consider a stablecoin lending stage *in-between* the adoption ($t = 0$) and conversion ($t = 1$) game
  - Large borrower; may be a speculator (Corsetti, Dasgupta, Morris, and Shin, 2004)
  - **Result:** Stablecoin lending tends to promote stability and adoption if the benefits are not eroded by speculation
    - ◇ Compelling rationale why stablecoin lending can drive demand: Gorton, Klee, Ross, Ross, and Vardoulakis (2022)
    - ◇ Lending is risky: d'Avernas, Maurin, and Vandeweyer (2022)

Conclusion

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- Modification of existing theories of bank runs and currency attacks by modeling stablecoin adoption and incorporating features of the stablecoins market
- Key ingredient: demand for stablecoins is created by heterogeneity in induced payment preferences
- Results
  1. Downsides from wider adoption; two relevant externalitites
  2. Insights for the risk assessment of stablecoins from the study of the determinants of adoption and fragility
  3. Support for a regulatory disclosure regime and rules on reserves and the capitalization of issuers
  4. A set of new testable implications

Appendix

The Stablecoins Market

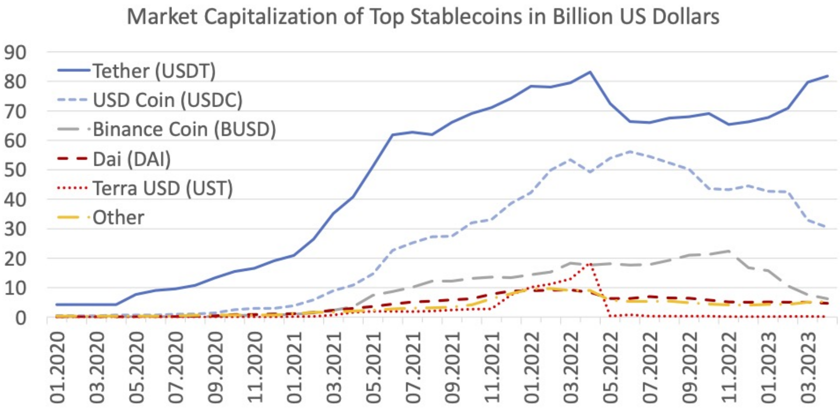

Figure: Market capitalization of top stablecoins over the period from end of Jan. 2020 to end of April 2023. Data: coingecko.com.

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Related Literature

- Global games bank run and currency attack models (Morris and Shin 1998; Rochet and Vives 2004; Goldstein and Pauzner 2005) with heterogeneous payoffs (Corsetti, Dasgupta, Morris, and Shin 2004; Sákovics and Steiner 2012)
- Adoption of different means of payment and of crypto assets (Agur, Ari, and Dell'Ariccia 2022; Cong, Li, and Wang 2021) and the role of digital platforms (Chiu, Davoodalhosseini, Jiang, and Zhu 2022)
- Stablecoins
  - Global games: Gorton, Klee, Ross, Ross, and Vardoulakis (2022) on stablecoin lending and the peg; Routledge and Zetlin-Jones (2021) on dynamic devaluations to eliminate speculative attacks; Bolt, Frost, Shin, and Wierts (2023) on the service value of fiat money and vulnerability
  - Others: Klages-Mundt and Minca (2022); Li and Mayer (2022); d'Avernas, Maurin, and Vandeweyer (2022)

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What are the Key Risks for Coin Holders?

It may not always be possible to redeem the coins at par ▸ Back

- **Asset return, liquidity and custodial risk**
- Operational risk and technological risk (e.g. cyber risk)

Assets			**Value in bn USD**
Commercial Paper & Certificates of Deposit			8,402
	A-1+ rating	1,434	
	A-1 rating	5,465	
	A-2 rating	1.499	
Cash & Bank Deposits			5,418
Reverse Repurchase Agreements			2,992
Money Market Funds			6,810
Treasury Bills			28,856
Non-U.S. Treasury Bills			397
Secured Loans			2,992
Corporate Bonds, Funds & Precious Metals			3,487
Other Investments (including digital tokens)			5,551
Total			**66,410**

Table: UST asset breakdown 30 June 2022. Assurance opinion by *BDO*, Italy.

Timeline

Date 0	Date 1	Date 2
1. **Adoption game:** Consumers simultaneously decide whether to convert their bank deposits to stablecoins, $a_{0,i} = 1$, or not, $a_{0,i} = 0$ 2. The stablecoin issuer invests all funds received from consumers who adopt stablecoins	3. The fundamental θ is realized but unobserved and a fraction κ of coin holders become active 4. **Stablecoin conversion game:** Active stablecoin holders receive the private signal x_i and decide simultaneously whether to demand conversion to deposits, $a_{1,i} = 1$, or not, $a_{1,i} = 0$, while passive coin holders are dormant 5. The stablecoin issuer meets coin holders' conversion requests by divesting assets	6. The outcome of the $t = 1$ stablecoin conversion game and the fundamental realization θ are observed; the preference of each consumer is realized 7. If the issuer's reserves fall short of the face value of claims held by the remaining active and passive coin holders, the issuer is insolvent and the stablecoins are devalued 8. Consumers buy goods from their preferred seller and convert their money (if necessary) 9. Sellers A and C convert the stablecoins earned; all sellers pay production costs with government-backed deposits (or dollars)

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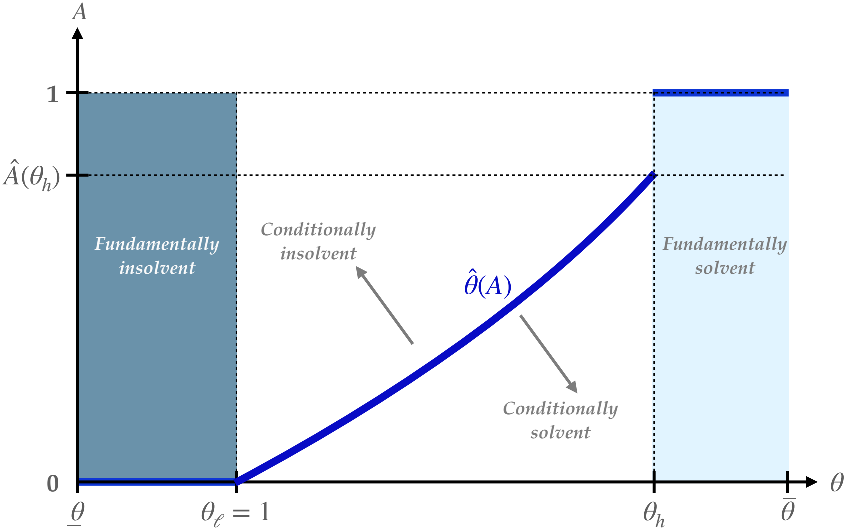
Solvency of the Stablecoin Issuer

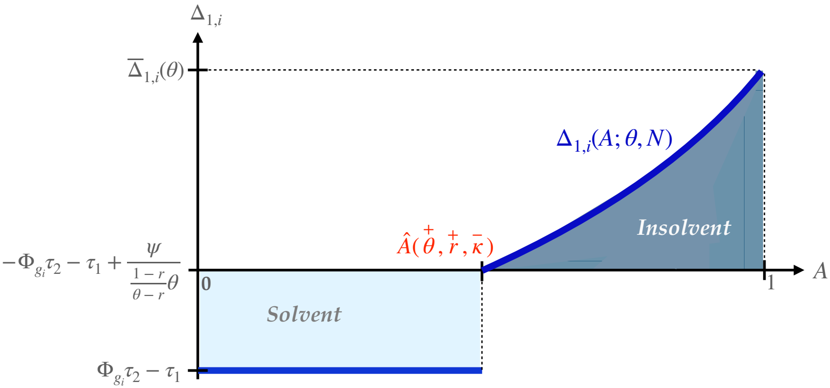
- **Ass.:** $\overline{\theta} > \theta_h \equiv (1-\kappa)r/(r-\kappa) > 1 \Rightarrow$ the issuer can meet all redemption requests at $t = 1, 2$ if $\theta \in [\theta_h, \overline{\theta}]$
- **Ass.:** $\kappa < r \Rightarrow$ the issuer can always meet redemption requests by active coin holders at $t = 1$
- **Insolvency:** For $\theta < \theta_h$ the issuer is cash-flow insolvent if she is unable to meet her $t = 2$ payment obligations:

$$\kappa(1-A) + 1 - \kappa > \frac{r - \kappa A}{r}\theta$$

Solvency as a Function of θ and A



Benefit from demanding conversion, given θ and A



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Continuation Equilibrium at $t = 1$ for a given N

Proposition 2

Given Assumption 1, $\sigma \to 0$ and a positive level of adoption $N > 0$, there exists a unique monotone equilibrium of the conversion game where active coin holders demand conversion iff they receive a private signal below their group-specific signal threshold x_g^*, i.e. for $x_i \leq x_g^*$, and where the issuer faces a run at $t = 1$ for all $\theta < \theta^*$, where $\theta^* \in (1, \theta_h)$ solves:

$$(\beta(N) - \alpha(N))\tau_2 - \tau_1 - 2\tau_2\overline{\gamma} + \int_{\frac{(\theta^*-1)r}{\kappa(\theta^*-r)}}^{1} \left(1 - \frac{\frac{r-\kappa A}{r}\theta^* - \psi}{1-\kappa A}\right) dA = 0,$$

with $\overline{\gamma} \equiv (\mu_s m_s \gamma_s + \Sigma_{g=s+1}^{G} m_g \gamma_g)/(\mu_s m_s + \Sigma_{g=s+1}^{G} m_g)$.

Assumption 1

Let $\underline{\theta} < 1 - \sigma\epsilon$, $\theta_h + \sigma\epsilon < \overline{\theta}$, $\kappa \leq \overline{\kappa}$ and $\psi \in (\underline{\psi}, \underline{\theta})$.

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