# Stablecoins: Adoption and Fragility

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**Abstract**

This paper analyzes the factors influencing the adoption of stablecoins and their susceptibility to runs, offering insights for risk assessment and appropriate regulation, as well as new testable implications. When payment preferences are heterogeneous, a wider adoption of stablecoins is associated with a destabilizing composition effect. Positive network effects mitigate the destabilizing composition effect, but may undermine the role of bank deposits in payments. Since the marginal adopter of stablecoins does not internalize these effects, the regulatory concern about excessive adoption is justified. The introduction of a portfolio choice by the stablecoin issuer and moral hazard provide additional lessons for reserve management and disclosure. Factors that increase the issuer's income from fees and seigniorage promote stability, as do congestion effects. A stablecoin lending market promotes both stability and adoption, if it is not undermined by speculation.

**Keywords:** Stablecoins, money, payment preferences, financial stability, financial regulation, global games.

**JEL Classification:** D83, E4, G01, G28.

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# 1 Introduction

Stablecoins are a new form of digital private money that promises a stable and secure way to park funds in the crypto universe. However, stablecoin issuers are vulnerable to runs triggered by negative information about the quality and liquidity of their reserves, as well as custodial, operational, and technological risks (e.g. cyber risk). The goal of this paper is to explore the factors that determine stablecoin adoption and fragility, as well as the relationship between the two. The key research questions are, first, how is the fragility of stablecoins influenced by their adoption? Second, what conditions can lead to excessive stablecoin adoption? And third, how is fragility affected by various factors such as payment preferences, network effects, transaction costs, stablecoin lending, and moral hazard problems faced by issuers? To answer these questions and to provide insights for the risk assessment and appropriate regulation, I develop a theoretical model.

The dominant stablecoins are pegged one-to-one to the US dollar and reside on a blockchain. This allows them to serve as a critical link between the rapidly evolving crypto universe and traditional financial markets (Barthelemy, Gardin and Nguyen 2021; Kim 2022). Figure 1 shows the evolution of the market capitalization of the top stablecoins since January 2020. After a breakneck expansion in 2021, when the market grew nearly five-fold, the pace of growth slowed down markedly, followed by a correction during the crypto market turmoil in May 2022, when the total market capitalization dropped from close to 190bn to around 150bn US dollars after a wave of redemptions. Following a brief recovery, the renewed crypto market turmoil in November 2022 during the failure of the FTX crypto exchange and lawsuits affecting the issuance and exchange of USD Coin (USDC) and Binance Coin (BUSD), which are associated with the Binance and Coinbase cyptocurrency exchanges, prevented the stablecoins market to continue its expansion.[1] While the second and third largest stablecoins USDC and BUSD suffered large outflows, the largest stablecoin Tether (UST) has gained market share and reached an all-time high with a market capitalization of more than 83bn US dollars in July 2023. As a result, the already concentrated stablecoin market has become even more concentrated, with a Herfindahl-Hirschman Index of 50%.

Unlike Bitcoin or Ether, which have no intrinsic value and are highly volatile, the leading stablecoins are backed by fiat currency or by other assets, allowing crypto investors to park their funds and to reduce trading costs across cryptocurrency exchanges. Stablecoin arrangements can also offer greater transaction speed and privacy, which is attractive for illicit uses. Other use cases include low-cost remittances and potentially access to a substitute for volatile fiat currencies under devaluation pressure, as well as an escape from financial repression. This makes stablecoins suitable as a form of private money, with a potential for wider adoption in cross-border transactions and financial markets more generally. It is, however, unclear whether today's stablecoins can serve as an effective and widely accepted medium of exchange beyond certain use cases due to their

[1] In February 2023, New York regulators halted the issuance of BUSD, while the U.S. Securities and Exchange Commission (SEC) and the U.S. Commodity Futures Trading Commission (CFTC) filed lawsuits against Binance (see `https://www.cftc.gov/PressRoom/PressReleases/8680-23`, `https://www.sec.gov/news/press-release/2023-101`) and Coinbase (see `https://www.sec.gov/news/press-release/2023-102`).

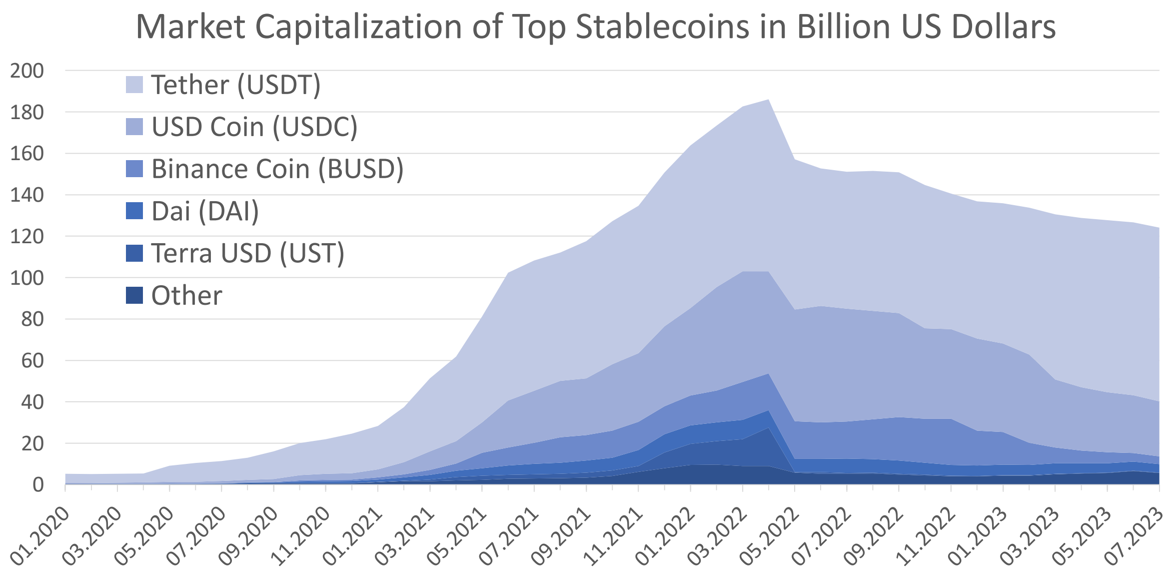


Figure 1: End of month market capitalization over the period from January 2020 to July 2023, when the combined end-of-period capitalization stood at around $125bn. Source: coingecko.com.

fragility and technical limitations in payments processing.[2]

Financial regulators were alerted to stablecoins after social media platform Facebook announced in June 2019 that it would launch its own digital currency called "Libra," sparking extensive policy discussion (G7 2019; FSB 2019; Brainard 2019; Cœuré 2019; Adrian and Mancini-Griffoli 2019). While Facebook abandoned the project in January 2022 after facing regulatory headwinds, the potential for widespread adoption of stablecoins, their fragility, as well as their impact on the stability of traditional financial markets and the monetary system remains a major concern for policymakers, as reflected in recent lawsuits by U.S. regulators (see footnote 1).

There have already been instances of runs against stablecoins. Most prominently, the destructive run against the algorithmic stablecoin Terra USD. Up until May 2022, UST has been trading in a narrow band around its peg to the US dollar for almost one year, which includes a period of rapid growth in its market capitalization from 2.8bn US dollars at the end of October 2021 to 18.7bn US dollars in early May 2022. On May 9 UST suffered a wave of redemptions that resulted in the unmooring of the peg to the dollar, the halting of the Terra blockchain and a rapid collapse of the market price to near zero over the next few days.[3] After its collapse, UST never recovered, as can be seen in Figure 1. On May 12, USDT, the largest stablecoin that is mostly backed by fiat currency, also suffered a short-lived 5% price drop after experiencing a 3-4bn US dollars redemption wave. More recently, the fully backed USDC broke its peg and sank to 0.87 cents on March 11, 2023 after the collapse of Silicon Valley Bank (SVB). The temporary unpegging happened for fundamental

[2]See Ho, Darbha, Gorelkina and Garcia (2022) for a Bank of Canada review of stablecoin use cases, risks and benefits.
[3]See Figure A1 in the Appendix and Liu, Makarov and Schoar (2023) for a detailed analysis of the run on UST.

reasons, as the USDC issuer Circle held 3.3bn US dollars of its reserves at SVB.[4] Ultimately, the swift announcement by U.S. regulators to protect all uninsured SVB deposits came before Circle had to begin meeting redemption requests, potentially saving USDC from a destructive run.

The risk of concentrated holdings of uninsured deposits is only one of the risks facing today's stablecoins. Most stablecoin issuers engage in some degree of maturity and liquidity transformation, similar to money market funds. In addition, issuers hold assets with varying degrees of credit risk. The actual risk exposure is often difficult for coin holders to assess due to a lack of detailed and verifiable information about issuers' reserves. A case in point is the largest stablecoin, Tether, which is pegged to the US dollar. While Tether claims that each "token is always 100% backed by our reserves," this has been challenged in court,[5] and the transparency about the asset composition and risk profile remains limited (see Appendix A.2 for more details). Since Tether's reserves are located in Cayman Islands, they are not verifiable and the bankruptcy process is unclear. Also custodial and cyber risks create vulnerablilities. Thus, the value of stablecoins is information sensitive (Dang, Gorton and Holmström 2021); in stark contrast to insured bank deposits.[6]

I develop a theoretical model that captures the fragility of stablecoins stemming from concerns about the quality of the issuer's assets and potential exposures to other risk. The theory allows to study the determinants of stablecoin adoption and fragility, as well as aspects related to disclosure of information about the quality of assets and the appropriate regulation of stablecoins. I model a stablecoin run as a global game of regime change (Carlsson and van Damme 1993; Vives 2005). Global games have been used extensively to study bank runs, currency attacks and debt runs. This class of models is particularly well suited to studying stablecoin runs, since stablecoin issuers operate a unilateral exchange rate peg and share the same vulnerabilities as uninsured bank debt. Compared to standard banking models, the main theoretical contribution is the introduction of an adoption game at the ex-ante stage and of heterogeneous payment preferences, which requires allowing for heterogeneous payoffs (Sákovics and Steiner 2012). While the liability structure is typically taken as given in a Diamond and Dybvig (1983)-type model, where the bank chooses assets to trade off returns, liquidity provision and run risk, my theory endogenizes the liability side by modeling adoption, where consumers trade off the benefits from stablecoins with the return differential relative to insured bank deposits and the risk of devaluation.

The baseline model has three dates and considers a stablecoin that is pegged to a single fiat currency. At the initial date, consumers decide whether to hold stablecoins or insured bank deposits. Thereby, consumers take into account the likelihood that stablecoins or bank deposits

[4] See `https://www.circle.com/blog/an-update-on-usdc-and-silicon-valley-bank`.

[5] Tether was sued by New York State Attorney General Letitia James for failing to fully back each Tether at all times and agreed to pay a fine of 18.5m US dollars in February 2021.

[6] In addition to the described risks associated with the leading stablecoins USDT, USDC and BUSD, which are (fully) backed by (mostly) traditional financial assets, the so called algorithmic stablecoins like DAI and the now defunct UST are either crypto-backed or unbacked, which exposes them to additional vulnerabilities. They use algorithmic stabilization mechanisms maintain the peg with a fiat currency. In the case of DAI the stablecoins are collateralized with other crypto assets, while UST relied on an arbitrage relationship with another crypto asset called Luna. This exposes algorithmic stablecoins to the risk that the underlying crypto assets abruptly loose value or become illiquid, as happened to UST in May 2022, thereby compounding the inherent vulnerabilities described above.

are the preferred means of payment in the terminal period, which matters because consumers incur transaction costs if they are not in possession of the means of payment that is accepted by the consumption good seller from whom they want to buy the good. At the intermediate date a run occurs if enough coin holders demand conversion to deposits, such that the stablecoin issuer becomes insolvent. As standard in the global games literature, coin holders receive a noisy private signal that is correlated with the issuer's fundamental before deciding whether or not to demand conversion. There exists a unique monotone equilibrium of the conversion game where coin holders optimally demand conversion at the intermediate date whenever they receive a private signal that is below a certain threshold, suggesting an unfavorable fundamental realization. I analyze how this signal threshold and, hence, the probability of runs depends on various factors that play an important role in the market for stablecoins. Moreover, I take the effect on the optimal stablecoin adoption decisions at the initial date into account.

In practice, crypto investors are very diverse, and their demand for stablecoins is influenced by preferences, such as a love for anonymity, the convenience relative to other means of payment and potential transaction cost advantages for specific use cases such as for remittances.[7] Motivated by this diversity, I generate the demand for stablecoins by introducing a heterogeneity among consumers in their consumption preference. Specifically, consumers face a group-specific probability of wanting to purchase the good from a seller who has a payment preference for stablecoins instead of bank deposits. Hence, consumers in groups with a high "induced payment preference" for stablecoins optimally adopt stablecoins at the initial date, while others keep their deposits.

I identify two mechanisms that can justify the regulatory community's concern about excessive stablecoin adoption. First, the marginal adopter does not internalize that a wider adoption of stablecoins is associated with a destabilizing composition effect. This effect arises because new coin holders, in contrast to early adopters who are often referred to as "crypto enthusiasts," display less enthusiasm towards stablecoins. Therefore, the flightiness of coin holders at the interim date increases, as does the issuer's fragility. From a regulatory perspective, I call this the "Tether scenario," where a wider adoption of stablecoins for new use cases raises concerns about stability. Second, the marginal adopter does not internalize network effects, which can undermine the role of bank deposits as a means of payment. I call this the "Facebook Libra scenario," where a key concern for regulators is the potential for a rapid and widespread adoption that leads to disintermediation.

Regarding the determinants of fragility, I find that most factors that increase the attractiveness of stablecoins also reduce fragility. Intuitively, factors that promote stablecoin adoption also tend to make the marginal coin holder, who is indifferent between keeping her stablecoins and demanding conversion at the interim date, less flighty. This is the case for an increase in the likelihood that stablecoins are the preferred means of payment. A higher adoption, in turn, can reduce fragility if fixed operating costs can be spread across a larger user base and if there are positive network

[7] Cryptocurrency exchange platforms see remittances as an area with growth potential. In 2022 the Coinbase platform began offering crypto remittances to Mexico. The new service allows to instantly send crypto assets and stablecoins, promising $25 - 50\%$ lower transaction costs when compared to traditional cross-border transactions.

effects that promote the use of stablecoins as a means of payment. However, in the absence of such factors, higher adoption increases the likelihood of runs due to the destabilizing composition effect described above. Also factors that increase the issuer's revenue from fees and seigniorage promote stability, as do congestion effects that are associated with an increase in transaction costs during times of stress; a widespread phenomenon in crypto networks using decentralized ledger technologies.[8] Perhaps surprisingly, the stabilizing effect of endogenous transaction costs leads to a lower probability of runs, even when the costs are lower than the exogenous transaction costs in the baseline model for a wide range of aggregate conversion demands.

I consider several extensions of the baseline model. Introducing a portfolio choice problem for the stablecoin issuer, I find that she has an incentive to choose a risky portfolio without commitment. Even a regulatory disclosure regime that allows the issuer to credibly commit to a low-risk portfolio choice may be insufficient to achieve the socially optimal level of portfolio risk. This finding can rationalize the use of capital requirements and of additional regulatory measures that infer with the issuer's risk choice, as to ensure the quality of the assets backing the coins and to reduce operational and custodial risks. In another extension, I introduce a stablecoin lending market. Crypto lending markets have become increasingly popular, and I find that stablecoin lending promotes both stability and adoption, as long as the benefits are not undermined by speculation. In addition, the stablecoin lending rate can inform the regulatory risk assessment, with a higher lending rate being associated with greater fragility.

There is a growing body of empirical studies on stablecoins, which I discuss below. My model allows me to develop a set of novel testable implications that link measurable market characteristics with market outcomes. Moreover, I discuss pathways to bring them to the data. From a policy viewpoint, I highlight the built-in fragility of the latest innovation in the history of private money and the determinants of fragility identified in this paper can inform the ongoing policy debate.

My paper relates to the extensive theoretical research on currency attacks (Krugman 1979; Flood and Garber 1984; Obstfeld 1986; Morris and Shin 1998; Corsetti, Dasgupta, Morris and Shin 2004) and bank runs (Rochet and Vives 2004; Goldstein and Pauzner 2005). In a recent paper Routledge and Zetlin-Jones (2021) analyze a currency attack model and study the vulnerability of a currency, or stablecoin, that is not 100% backed by a reserve currency and study how a commitment to devalue the currency conditional on the size of a speculative attack can successfully stabilize the exchange rate. Motivated by the fall of the Bank of Amsterdam, Bolt, Frost, Shin and Wierts (2023) show how a negative shock to the service value of fiat money can make it more vulnerable to adverse fundamentals and to an insufficient capitalization of the central bank. Gorton, Klee, Ross, Ross and Vardoulakis (2022b) offer a compelling rationale why stablecoin lending can drive demand for stablecoins, while Ahmed, Aldasoro and Duley (2023) study theoretically and empirically the ambiguous role of transparency, and Ma, Zeng and Zhang (2023) investigate the effects of

[8]Due to capacity limits of the Ethereum blockchain, the fees for on-chain transactions are positively associated with trading volumes. The run against Terra USD in May 2022 is a case in point, when the Ethereum gas price quadrupled (see Figure A1 in the Appendix), which may have contributed to stabilizing the peg of Tether.

centralized arbitrage on the run risk and secondary market price dislocations of stablecoins, using a global games framework. My focus differs in that I offer a closer examination of the determinants of adoption and fragility of stablecoins with a view on the risk assessment and appropriate regulation. In other related work, Uhlig (2022) offers a theory that generates a gradual unfolding of the LUNA and UST crash, as well as a quantitative interpretation. Li and Mayer (2022) develop a dynamic model of stablecoin and crypto shadow banking to characterize an instability trap where tokens are debased in states where the issuer has a low level of reserves. Meanwhile, d'Avernas, Maurin and Vandeweyer (2022) explore the use of smart contracts to enforce pre-determined rules that prevent over-issuance, and Klages-Mundt and Minca (2021) study alternative stabilization mechanisms.

My paper also relates to the growing literatures on digital money, crypto assets and central bank digital currencies (CBDC). Agur, Ari and Dell'Ariccia (2022) study the optimal design of a CBDC with an emphasis on network effects and the convenience of different means of payment; two aspects that also feature in my paper. Adoption also plays an important role for e-commerce platforms such as Alibaba. Chiu and Wong (2021) study the business model of platforms, who have the choice between accepting cash and issuing digital money, and whether to allow the digital money they issue to circulate outside the platform. Cong, Li and Wang (2021) study how user network externalities shape crypto asset adoption and increase the price, which in turn accelerates adoption. Ahnert, Hoffmann and Monnet (2022) analyze the choice of using CBDC for payments with a view on privacy. Andolfatto (2021a) and Chiu, Davoodalhosseini, Jiang and Zhu (2022) argue that CBDC does not lead to undesirable disintermediation and can increase competition in banking. Other papers on disintermediation and the stability of banks include Whited, Wu and Xiao (2022), Barrdear and Kumhof (2021), Davoodalhosseini (2021), Schilling, Uhlig and Fernández-Villaverde (2021), Keister and Monnet (2020) and Williamson (2021).

The paper is organized as follows. The environment is described in Section 2. The model is then solved in Section 3, followed by a policy analysis in Section 4. Section 5 discusses several extensions and additional insights for risk assessment. Section 6 presents testable implications. Finally, Section 7 concludes. All proofs are in the Appendix.

## 2 Environment

Consider a game with three dates ($t = 0, 1, 2$) that comprises an initial *stablecoin adoption* (or investment) game played at time 0 and a *stablecoin conversion* (or withdrawal) game played at time 1, which takes the form of a global game of regime change. The economy has a unit continuum of risk-neutral consumers indexed by $i \in [0, 1]$, a monopolistic stablecoin issuer and three competitive consumption good sellers indexed by $\mathcal{A}$, $\mathcal{B}$ and $\mathcal{C}$. There are two different monies: insured bank deposits and stablecoins. Consumers derive utility from consuming at time 2.

**Endowments and production.** At time 0 each consumer is endowed with a bank deposit that is worth \$1. Sellers have no endowment and operate a constant returns to scale technology to produce a divisible consumption good at time 2. The unit cost of production is normalized to \$1, so competitive sellers charge a price of \$1. The quantities produced by sellers $\mathcal{A}$, $\mathcal{B}$ and $\mathcal{C}$ are denoted with $c_A$, $c_B$ and $c_C$, respectively.

**Insured bank deposits and stablecoins.** Consumers can transfer their dollar endowments from time 0 to the consumption stage at time 2 by holding insured bank deposits or stablecoins. Deposits are modeled as an "outside option" with an exogenous risk-free interest rate $r^D \geq 0$ when held from time 0 to time 2 and with a (cash-like) zero interest rate when held short-term from time 0 to 1 or from time 1 to 2. Instead, stablecoins are pegged one-to-one to the dollar, as observed in practice.

**Accepted form of payment by sellers.** Seller $\mathcal{A}$ (Seller $\mathcal{B}$) *only accepts* a transfer of stablecoins (bank deposits) with the corresponding dollar value as payment, and seller $\mathcal{C}$ *accepts both* deposits and stablecoins of equal value. Importantly, all sellers must pay production costs at the end of time 2 by transferring government-backed bank deposits (or dollars), meaning that sellers $\mathcal{A}$ and $\mathcal{C}$ must convert the stablecoins they receive.

**Consumption preference risk.** Consumers buy the good from sellers and cannot trade directly with each other. They face idiosyncratic risk about their consumption preference (or *payment type*), which is realized at time 2. With probability $0 < \alpha_i < 1$ consumer $i$ only values the goods sold by seller $\mathcal{A}$, with probability $0 < \beta_i < 1$ she only values the goods sold by seller $\mathcal{B}$, and with probability $0 \leq 1 - \alpha_i - \beta_i < 1$ she only values the goods sold by seller $\mathcal{C}$. The utility function of consumer $i$ reflects the heterogeneity in payment types:[9]

$$u_i(c_{i,A}, c_{i,B}, c_{i,C}) = \begin{cases} c_{i,A} \text{ , } w.p. \ \alpha_i > 0 \\ c_{i,B} \text{ , } w.p. \ \beta_i > 0 \\ c_{i,C} \text{ , } w.p. \ 1 - \alpha_i - \beta_i \geq 0 \end{cases} \qquad \begin{array}{c} \underline{\text{payment type}} \\ \text{stablecoins} \\ \text{bank deposits} \\ \text{both} \end{array}$$

where $c_{i,A}$, $c_{i,B}$ and $c_{i,C}$ denote consumer $i$'s time 2 consumption of goods sold by sellers of type $\mathcal{A}$, $\mathcal{B}$ and $\mathcal{C}$, respectively. The preference states are drawn independently, meaning that in the aggregate a mass $\alpha = \int_i \alpha_i di$ want to buy from seller $\mathcal{A}$, a mass $\beta = \int_i \beta_i di$ from seller $\mathcal{B}$, and a mass $1 - \alpha - \beta$ from seller $\mathcal{C}$. Time $t = 2$ goods market clearing implies $c_A = \int_i c_{i,A} di$, $c_B = \int_i c_{i,B} di$ and $c_C = \int_i c_{i,C} di$.

A key model ingredient is that consumers differ in how attractive they find different monies (see, e.g., Agur, Ari and Dell'Ariccia (2022)), which generates a demand schedule for stablecoins. Formally, it is assumed that there are $G$ groups of consumers indexed by $g \in \{1, ..., G\}$, where $g_i$ denotes the group to which consumer $i$ belongs. Each group has a measure $m_g$, where $\Sigma_{g=1}^{G} m_g = 1$. The payment type probabilities have a common and a group specific component, $\alpha_g = \alpha + \gamma_g$ and $\beta_g = \beta - \gamma_g$, where $\gamma_{g+1} > \gamma_g \geq 0, \forall g \in \{1, ..., G-1\}$. The group specific component captures the consumption preference risk heterogeneity and generates a higher attractiveness of stablecoins for

[9] The exclusive preference for a seller simplifies the exposition and can be relaxed to a relative preference.

consumers belonging to a group with a higher $g$. To assure that $\alpha_g, \beta_g \geq 0$ and $\alpha_g + \beta_g \in [0,1]$ holds for all groups, let $\alpha \geq 0$, $\beta - \gamma_G \geq 0$, $\beta \leq 1$ and $\alpha + \gamma_G \leq 1$.

The consumption preference risk matters because of two frictions: *(a)* consumption good sellers accept different monies and *(b)* consumers who don't have the money that is accepted for the purchase of the desired goods at time 2 must first convert monies, which involves transaction costs, as described below. The resulting *induced payment preference* is as a proxy for the medium of exchange function of the two monies, and the heterogeneity generates a demand for stablecoins that captures the varying interest of consumers in crypto applications and aspects such as anonymity, or real-world use cases such as low-cost remittances.

**Transaction costs.** When converting deposits into stablecoins and vice versa, consumers incur fixed transaction costs that are exogenously given and designed to capture transaction fees and convenience costs. The transaction costs at times $0, 1, 2$ are measured in dollars and denoted with $\tau_0$, $\tau_1$ and $\tau_2$. A key model assumption is that there is an advantage to having the "right money on hand" at time 2, i.e., the cost of converting from one money to another at short notice is higher than the cost of an ex-ante conversion at time 0, i.e. $\tau_0 \leq \tau_1, \tau_2$. This assumption can, for instance, be motivated by transaction processing times and the inability to time the conversion for a window of low network activity. For simplicity, I assume that $\tau_0 = 0$.[10]

**Stablecoin issuer.** The monopolistic issuer offers to convert deposits into a digital token (stablecoin) and vice versa at a one-to-one conversion rate at times $0, 1, 2$.[11] Unlike deposits, stablecoins pay no interest and the issuer may not always be able to redeem the coins at par as promised due to the *risk of insolvency*. Formally, the funds collected by the issuer at time 0 are invested in a risky asset that pays off $\theta$ dollars at time 2 per dollar invested at time 0, where $\theta \sim U[\underline{\theta}, \overline{\theta}]$, with $0 \leq \underline{\theta} < 1 \leq \overline{\theta}$. If divested prematurely the asset pays off $0 < r \leq \underline{\theta}$ dollars at time 1 per dollar invested at time 0.[12] Moreover, there is a bankruptcy cost $\psi > 0$ if the value of the issuer's assets falls below the dollar face value of the remaining coins in circulation. In this case, the coins are *devalued* in accordance with the liquidation value of the issuer. In practice, the riskiness of the issuer's balance sheet may stem from the quality of the assets or from potential exposures to custodial, operational or technological risks (e.g. cyber risk). The fundamental $\theta$ is meant to capture

[10]The results are robust as long as $\tau_0$ is sufficiently small relative to future transaction costs. Sections and 5 discusses variants of the model where part (or all) of the transaction costs are captured by the stablecoin issuer, and where $\tau_1$ endogenously responds to the spikes in transaction volumes. Figure A1 illustrates the elevated level of transaction fees during a period of crypto market turmoil. Transaction fees depend on market-wide conditions, as the same blockchain is used by many cryptocurrencies. Therefore, assuming an exogenous conversion cost is a good starting point. In practice, issuers have no control over transaction costs for on-chain transactions and for peer-to-peer transactions (which depend on fees on the Ethereum blockchain or of a peer-to-peer exchange). However, issuers might exert certain influence over the fees on cryptocurrency exchange platforms (e.g. USD Coin is co-owned by the exchange Coinbase and Binance USD is owned by the exchange Binance). These platforms also offer VISA/MasterCard payment cards enabling cryptocurrency spending and ATM withdrawals (e.g. Coinbase offers a VISA card issued by MetaBank).

[11]All top stablecoin issuers, as well as mobile money and e-money operators, use a one-to-one conversion promise, and it would require a richer modeling environment to make it an optimal contract. The closest analogy is a fixed exchange rate regime.

[12]The implicit assumption that early closure is never ex-post efficient is standard. See Rochet and Vives (2004) for a distinction between efficient and inefficient liquidations based on a moral hazard consideration.

these risks in a reduced form. Importantly, $\underline{\theta} < 1$ gives rise to states of the world where the value of stablecoins falls below $1 even if there are no redemption requests at time 1. This assumption is consistent with the current business models of the leading stablecoin issuers, which hold risky assets (see Table A2) and are thinly capitalized.[13]

**Stablecoin adoption game.** At time 0 consumers simultaneously decide whether to keep their endowment of $1 in bank deposits or, alternatively, convert their deposits to stablecoins. In their decision consumers take their expected payment type, the interest rate differential and the potential devaluation of stablecoins into account. Given the linearity, it is sufficient to restrict attention to a binary action game. Let $a_{0,i} \in \{0, 1\}$ denote the action of consumer $i$ at time 0, where $a_{0,i} = 1$ if she converts all her deposits to stablecoins and $a_{0,i} = 0$ if she keeps all deposits till time 2. The stablecoin adoption rate is defined as $N = \int_0^n a_{0,i} di \in [0, 1]$.

**Stablecoin conversion game.** At time 1 stablecoin holders are randomly assigned a type, with probability $0 < \kappa \leq 1$ they become *active holders* and with probability $1 - \kappa$ they are *passive holders*. Active coin holders decide at time 1 whether to reallocate their funds, while passive holders are dormant till time 2. In the baseline model there will be an upper bound on $\kappa$ to simplify the analysis by ruling out the possibility of rationing at time 1, as in Chen et al. (2010).[14] Following Carlsson and van Damme (1993), there is incomplete information about the issuer's fundamental $\theta$. At the beginning of time 1 each active stablecoin holder receives a noisy private signal $x_i$ that is correlated with the fundamental realization:

$$x_i = \theta + \sigma \varepsilon_i. \tag{1}$$

The idiosyncratic noise is independently and uniformly distributed, $\varepsilon_i \sim U[-\epsilon, +\epsilon]$ with $\epsilon > 0$ and $\sigma \geq 0$, where $g_i$ and $\varepsilon_i$ are uncorrelated. Active and passive coin holders are equally distributed across groups. Upon receiving their signal, active coin holders simultaneously decide whether to demand conversion to deposits at the promised one-to-one conversion rate, knowing that the issuer may not be able to meet all requests at par.[15] Let $a_{1,i} \in \{0, 1\}$ denote the action of consumer $i$ at time 1, where $a_{1,i} = 1$ if she is an active coin holder seeking conversion, and $a_{1,i} = 0$ if not.

Table A1 in the Appendix summarizes the game. Recall that all coins issued during the game are exchanged for their equivalent $ value at the end of time 2. Unlike consumers, sellers are not atomistic, and for them the fixed transaction cost $\tau_2$ to exchange coins earned at time 2 is negligible. The key difference from a standard bank run or currency attack model is the ex-ante adoption game that links stablecoin adoption and fragility, and the heterogeneity in stablecoin demand across consumers captured by the group specific induced payment preference. A necessary condition

[13]Section 5.5 considers an extension with $\underline{\theta} \geq 1$, $r'(\theta) > 0$ and $0 < r(\theta) \leq 1, \forall \theta \in [\underline{\theta}, \overline{\theta}]$, where the focus is purely on liquidity concerns.

[14]This modeling trick has no impact on the key insights and can be supported empirically. While there is a general consensus that transactions can be faster in the digital era, recent research identifies a large group of crypto investors who seem unskilled, lack attention, and are unable to respond to information in a timely manner (Liu et al. 2023).

[15]If the model is generalized to high levels of $\kappa$, I need to assume that conversion requests are met sequentially.

for a positive demand will be that the *crypto enthusiasts* belonging to the groups with the highest probability to meet seller $\mathcal{A}$ have an incentive to adopt stablecoins to economize on expected transaction costs, despite the interest rate differential and the risk of devaluation.

## 3 Solving the Model

The model has two stages, the adoption game at time 0 and the conversion game at time 1. I solve the mode backwards, starting at time 1 and taking the predetermined stablecoin adoption rate $N$ as given. Section 3.1 analyzes the problem of stablecoin holders at time 1, solves for the continuation equilibrium, and characterizes the equilibrium outcome, establishing a link between adoption and fragility. The coordination game played at time 1 is a standard global game of regime change, except for the heterogeneity in payoffs (Sákovics and Steiner 2012). After that, Section 3.2 presents the problem of consumers at time 0, defines a perfect Bayesian Nash equilibrium of the two-stage game, and discusses the beneficial role of stablecoins and the optimal stablecoin adoption decision, as well as the interaction between the fragility at time 1 and the adoption decision at time 0.

### 3.1 Stablecoin Runs at Time 1

Section 3.1.1 derives conditions under which the issuer is able to meet her payment obligations. Thereafter, Section 3.1.2 discusses how the expected payoff of an active coin holder depends on her conversion decision, the decision of other coin holders, and the solvency of the issuer. Building on these results, Section 3.1.3 states the time 1 decision problem and solves the conversion game. Finally, Section 3.1.4 characterizes the equilibrium and uncovers the determinants of fragility.

#### 3.1.1 Solvency of the Stablecoin Issuer

The stablecoin issuer is insolvent, whenever she is unable to redeem the coins at par that have been issued at time 0, meaning that she does not have sufficient resources to convert the stablecoins to bank deposits at the promised one-to-one conversion rate. Let $A = \int_i a_{1,i} di/(\kappa N)$ be the proportion of active coin holders who demand conversion at time 1 conditional on the adoption rate $N$. Let group $s$ denote the marginal group of coin holders with the lowest probability, $\alpha_s = \alpha + \gamma_s$, of benefitting from holding stablecoins instead of deposits, where Section 3.2 solves for $N$ and $s$. If only consumers belonging to groups $g \in \{s, ..., G\}$ hold coins at the beginning of time 1, then $A = \int_i a_{1,i} di/(\kappa \Sigma_{g=s}^{G} m_g) \in [0, 1]$, where $a_{1,i} = 0$ for all passive coin holders.

The issuer is cash-flow insolvent at time 1, i.e. unable to meet her immediate payment obligations $N\kappa A$, if $r < \kappa A$. This implies that she is also unable to meet her payment obligations at time 2. Conversely, solvency at time 2 implies that the issuer is also able to meet her payment obligations at time 1. Instead, if $r > \kappa A$ and:

$$(r - \kappa A)\frac{\theta}{r} < 1 - \kappa A, \tag{2}$$

the issuer can meet her immediate payment obligations, but not her time 2 payment obligations, $N(\kappa(1-A)+1-\kappa)$. When deriving the main results below, I invoke a parameter condition in Assumption 1, which implies that $r > \kappa$, meaning that there is no rationing at time 1. This simplifying assumption eases the analysis of the conversion game without affecting the key insights.

Next, I describe the regions of fundamental realizations where the issuer is *fundamentally solvent or insolvent* independent of the conversion demand by active coin holders at time 1. The region of fundamental solvency can be derived from Inequality (2), which implies that the issuer is able to meet all redemption requests at time 2 if $\theta \geq \theta_h \equiv (1-\kappa)r/(r-\kappa) > 1$. Following the global games bank run literature, I additionally invoke the mild parameter assumption that $\overline{\theta} > \theta_h$, meaning there exist sufficiently favorable fundamental realizations $\theta \in [\theta_h, \overline{\theta}]$ such that the issuer is *fundamentally solvent* independent of the conversion demand. The region of fundamental insolvency is derived by isolating $\theta$ in (2) to define a critical threshold $\hat{\theta}(A) \in [\underline{\theta}, \theta_h)$, such that for a given conversion demand, the issuer is insolvent for all $\theta < \hat{\theta}(A)$, where:

$$\hat{\theta}(A) \equiv \frac{(1-\kappa A)r}{r-\kappa A} > 1. \tag{3}$$

Based on Equation (3) there exists a lower bound $\theta_\ell = 1$ such that for all $\theta < \theta_\ell$ the issuer has insufficient resources at time 2 to meet her promise even if there are no conversion demands, i.e. if $A = 0$. Given that $\underline{\theta} < 1$, the issuer is *fundamentally insolvent* for all $\theta \in [\underline{\theta}, \theta_\ell)$. The two assumptions $\overline{\theta} > \theta_h$ and $\underline{\theta} < 1$ are used to establish an upper and a lower dominance region in Section 3.1.3.

Importantly, the solvency of the issuer depends on the level of the aggregate conversion demand $A$ in the intermediate range of fundamentals, $\theta \in (\theta_\ell, \theta_h)$. Equation (3) allows to trace out how solvency is governed by $A$, as illustrated in Figure A2 in the Appendix. Notably, a higher $\kappa$ (a higher $r$) makes it harder (easier) to assure solvency. Next, I analyze for the intermediate range of fundamentals the payoffs of active coin holders playing the conversion game at time 1.

### 3.1.2 Payoffs

The risk of insolvency only affects stablecoin holders, since bank deposits are insured. When deciding whether to demand conversion of her stablecoins to bank deposits at time 1, each active coin holder $i$ compares the expected utility payoff from doing so with the alternative to keep her coins. Table 1 shows the expected utility payoffs of coin holder $i$ of group $g_i$ associated with the two actions. Note that the payoffs depend on the realization of $\theta$, on the average action $A$ of others and on expected transaction costs weighted by the group-specific probabilities of the payment type.

Isolating the average action $A$ in Inequality (2) allows to define a critical threshold $\hat{A}(\theta)$, such

| *aggregate action* / *individual action* | $A \leq \hat{A}(\theta)$ issuer is solvent | $A > \hat{A}(\theta)$ issuer is insolvent |
|---|---|---|
| **Demand conversion**, $a_{1,i} = 1$ | $1 - \tau_1 - \alpha_i \tau_2$ | $1 - \tau_1 - \alpha_i \tau_2$ |
| **Keep coins**, $a_{1,i} = 0$ | $1 - \beta_i \tau_2$ | $\frac{\frac{r-\kappa A}{r}\theta - \psi}{1-\kappa A} - \beta_i \tau_2$ |

Table 1: Expected ex-post utility payoffs in the stablecoin conversion game at $t = 1$ for $\theta \in (\theta_\ell, \theta_h)$.

that for a given fundamental realization, the issuer is insolvent for all $A > \hat{A}(\theta)$, where:[16]

$$\hat{A}(\theta) \equiv \frac{(\theta - 1)r}{\kappa(\theta - r)} \in [0, 1], \forall \theta \in [\theta_\ell, \theta_h]. \tag{4}$$

In the intermediate region $\theta \in (\theta_\ell, \theta_h)$ payoffs depend on coin holder's beliefs about the aggregate action $A$ and the fundamental $\theta$. First, consider the case when the issuer is solvent, $A \leq \hat{A}(\theta)$. The issuer is able to meet her payment obligations in full to both active coin holders demanding conversion at time 1 and to the remaining active coin holders who keep their coins till time 2, as well as to passive coin holders. Therefore, all coin holders demanding conversion receive $1 - \tau_1$ dollars worth of bank deposits at time 1, after accounting for the conversion cost. This allows them to purchase $1 - \tau_1$ units of the good if they have a consumption preference for seller $\mathcal{B}$ or $C$, and $1 - \tau_1 - \tau_2$ units if they have a preference for seller $\mathcal{A}$, which occurs with probability $\alpha_{g_i}$. Given that the coins are not devalued at time 2 if $A \leq \hat{A}(\theta)$, all active coin holders who keep their coins at time 1 receive one unit consumption good if they have a preference for seller $\mathcal{A}$ or $C$, and $1 - \tau_1 - \tau_2$ units if they have a preference for seller $\mathcal{B}$, which occurs with probability $\beta_{g_i}$.

Next, consider the case when the issuer is insolvent, $A > \hat{A}(\theta)$. Now she is unable to meet her payment obligations in full to the remaining active coin holders who keep their coins till time 2, as well as to passive coin holders. However, all active coin holders demanding conversion at time 1 still receive the promised \$1 per stablecoin and have the same utility payoff as in the previous case. This is because the first inequality in (5) bounds $\kappa$ from above such that $r > \kappa$. Moreover, the bound on $\kappa$ and an additional bound on the bankruptcy cost $\psi$ ensure that the utility payoffs of both the passive coin holders and the remaining active coin holders are weakly positive, independent of $A$:

$$\kappa \leq \overline{\kappa} \equiv \frac{\underline{\theta} - \psi - \tau_2}{\underline{\theta} - r\tau_2} r < r \quad \Rightarrow \quad \frac{\frac{r-\kappa A}{r}\theta - \psi}{1 - \kappa A} - \tau_2 > 0 \text{ if } \psi < \underline{\theta}, \forall A > \hat{A}(\theta), \theta \in [\underline{\theta}, \overline{\theta}]. \tag{5}$$

The two conditions, $\kappa \leq \overline{\kappa}$ and $\psi \geq \underline{\theta}$, are summarized in Assumption 1 below and simplify the analysis by allowing to average over the group-specific terms when solving for the equilibrium by applying the Belief Constraint of Sákovics and Steiner (2012), as explained in Section 3.1.3.[17]

[16] Observe that $\hat{A}(\theta)$ is strictly increasing in $\theta$ and in $r$ for all $\theta \in (1, \theta_h)$, as the issuer is only insolvent at time 2 for higher levels of aggregate conversion demand at time 1. Moreover, $\hat{A}(\theta)$ is strictly decreasing in $\kappa$, as a higher share of active coin holders translates into it a higher conversion demand, thereby making it harder for the issuer to be solvent. Finally, note that $\hat{\theta}(A) \leq \theta_h$ requires $A < \hat{A}(\theta_h)$.

[17] The implicit assumption is that the use of stablecoins as a means of payment at time 2 is independent of the solvency

Let $\Delta_{1,i}(A;\theta) \equiv E[u_i(A, a_{0,i} = 1, a_{1,i} = 1;\theta)] - E[u_i(A, a_{0,i} = 1, a_{1,i} = 0;\theta)]$ denote coin holder i's differential payoff, or benefit, from demanding conversion at time 1, instead of keeping her coins:

$$\Delta_{1,i}(A;\theta) = \begin{cases} -\Phi_{g_i}\tau_2 - \tau_1 & \text{if } A \leq \hat{A}(\theta) \\ -\Phi_{g_i}\tau_2 - \tau_1 + 1 - \frac{\frac{r-\kappa A}{r}\theta - \psi}{1-\kappa A} & \text{if } A > \hat{A}(\theta), \end{cases} \tag{6}$$

where $\Phi_{g_i} \equiv [\alpha_i - \beta_i]\tau_2$. Note that $\Delta_{1,i}$ is weakly decreasing in $\theta$. Moreover, $\Delta_{1,i}$ is lower for coin holders belonging to a group with a higher probability to have a preference for seller $\mathscr{A}$, which, as will become clear below, implies a reduced flightiness.

Figure 2 illustrates how the differential utility payoff $\Delta_{1,i}(A;\theta)$ varies with $A$ for a given $\theta \in (1, \theta_h)$. If the issuer is solvent, i.e. for $A < \hat{A}(\theta)$, then $\Delta_{1,i}$ is (locally) invariant in the aggregate conversion demand and negative, meaning that there is no benefit from demanding conversion. As shown in Section 3.2, this is because consumer $i$ belonging to group $g_i$ would otherwise not have adopted stablecoins. Formally, $\Delta_{1,i} < 0, \forall g_i \geq s$ if $A < \hat{A}(\theta)$. Conversely, for $A > \hat{A}(\theta)$ there is a *global strategic complementarity* in actions; a higher $A$ strictly increases the incentives to demand conversion. Formally, $\Delta_{1,i}$ increases in $A$ and reaches its maximum value for $A = 1$, with $\Delta_{1,i}(1;\theta) > 0, \forall \theta \in (\theta_\ell, \theta_h), g_i \in \{s, ..., G\}$ under the sufficient condition that:

$$\psi > \underline{\psi} \equiv (\Phi_G\tau_2 + \tau_1)(1-\kappa). \tag{7}$$

The range for permissible bankruptcy costs, $\psi \in (\underline{\psi}, \underline{\theta})$, is non-empty provided the relative attractiveness from holding stablecoins is not implausibly high for the crypto enthusiasts in group $G$ and the conversion cost $\tau_1$ is not prohibitive. Formally, the lower bound for $\psi$ in (7) assures that even coin holders belonging to group $G$ have a benefit from demanding conversion at time 1 if they know that all other active coin holders demand conversion, i.e. $A = 1$, and that the fundamental realization is below $\theta_h$. Taken together, the benefit from demanding conversion, $\Delta_{1,i}$, depicted in Figure 2 is negative (positive) for small (large) values of $A$.

### 3.1.3 Equilibrium of the Stablecoin Conversion Game at Time 1

This section analyzes the decision problem of active coin holders at time 1 and derives the continuation equilibrium of the incomplete information game where $\sigma > 0$, meaning that coin holders receive a noisy private signal at time 1 that is correlated with the amount of resources available to the issuer at time 2. Recall that the marginal group $s \in \{1, ..., G\}$ is defined as the group of stablecoin adopters who find holding stablecoins least attractive, and that the number of groups

of the issuer. This assumption could, for instance, be rationalized because a new issuer enters the market or by the ability of the insolvent issuer to continue operating under resolution with a full backing by cash. The main insights of the paper do not hinge on this assumption and are robust to a relaxation of the upper bound on $\kappa$, which simplifies the payoff matrix and analysis of the run game as in Rochet and Vives (2004). Importantly, the analysis of the case with more than two different groups of coin holders is facilitated by the fact that the group-specific terms are not contingent on $A$ (Sákovics and Steiner 2012). See Goldstein and Pauzner (2005) for a bank run model with payoffs that do not satisfy global strategic complementarities, as it is the case in the alternative version of my model with $\kappa = 1$.

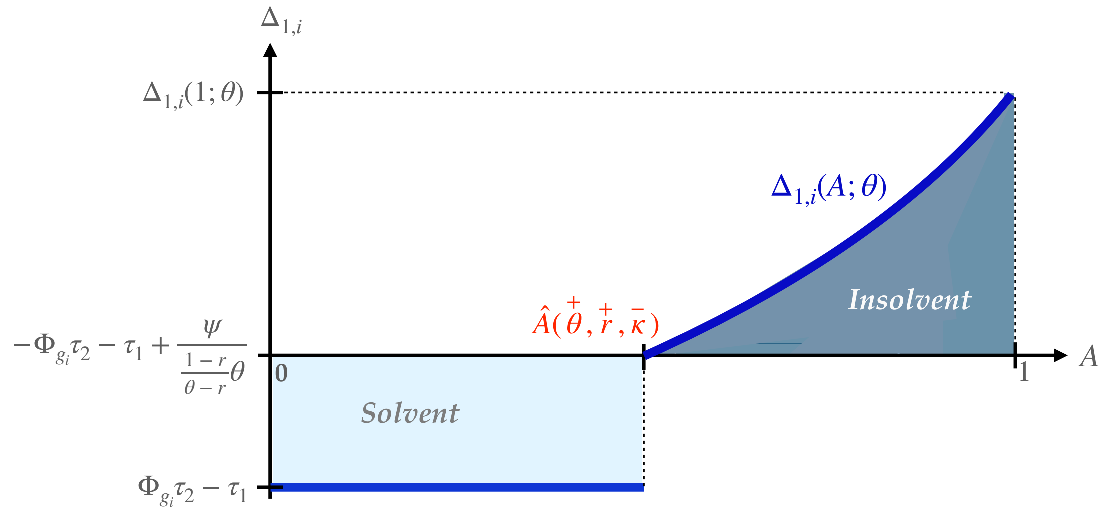


Figure 2: Differential utility payoff of a coin holder belonging to group $g_i$ from demanding conversion at time 1 instead of keeping her coins for a given fundamental $\theta$ and aggregate conversion demand $A$. If the issuer is insolvent, $A > \hat{A}(\theta)$, a higher $A$ strictly increases the benefit from demanding conversion. Note that $-\Phi_{g_i}\tau_2 - \tau_1 + \psi/((1-r)\theta/(\theta-r))$ is positive for all $g \in \{s, ..., G\}$ under the sufficient condition that the conversion cost is small relative to the bankruptcy cost.

of coin holders can be arbitrarily large. Building on the results from Section 3.1.2, Assumption 1 summarizes the key parameter conditions.

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

As common in the global games literature, I consider the case of vanishing private signal noise, i.e. $\sigma \searrow 0$, which also ensures that the first two inequalities in Assumption 1 always hold. The upper bound on $\kappa$ simplifies the payoff structure and ensures global strategic complementarity in actions (this assumption could be relaxed). The lower bound on $\psi$ focuses attention on the plausible case where even crypto enthusiasts have a benefit from demanding conversion if they know that everybody else wants to convert and $\theta < \theta_h$,[18] while the upper bound on $\psi$ avoids negative payoffs (this assumption could be relaxed).

**Expected benefit from conversion.** Using Equation (6), I define the differential expected payoff of coin holder $i$ from demanding conversion, i.e. $a_{1,i} = 1$, conditional on her private signal $x_i$:

$$\begin{aligned} E[\Delta_{1,i}(A;\theta)|x_i] \equiv\; & Prob\{A \le \hat{A}(\theta)|x_i\}\left((\beta-\alpha-2\gamma_i)\tau_2-\tau_1\right) \\ & + Prob\{A > \hat{A}(\theta)|x_i\}\int_{\underline{\theta}}^{\overline{\theta}}\left(1+(\beta-\alpha-2\gamma_i)\tau_2-\tau_1-\frac{\frac{r-\kappa A}{r}\theta-\psi}{1-\kappa A}\right)h(\theta|x_i)d\theta, \end{aligned} \tag{8}$$

[18] Intuitively, the condition assures for the intermediate region the co-existence of a pure strategy Nash equilibrium where all coin holders demand conversion in the complete information benchmark with $\sigma = 0$, as stated in Proposition 11 in Appendix Section A.3.

where $h(\theta|x_i)$ denotes the posterior probability of a fundamental realization of $\theta$, after observing the signal $x_i$. While coin holders potentially face heterogenous type-specific payoff functions, they all share an identical differential expected payoff conditional on their group and private signal.

I use the global games approach (Vives 2005; Morris and Shin 2006) to analyze the conversion game and to obtain conditions for the existence of a monotone Bayesian equilibrium. The posterior belief about the probability that the realization of $\theta$ exceeds the level $y \in [\underline{\theta} + \sigma\,\epsilon, \overline{\theta} - \sigma\,\epsilon]$ is:

$$Prob\{\theta \geq y|x_i\} = Prob\{x_i - \sigma\varepsilon_i \geq y|x_i\} = \begin{cases} 1 & if\; x_i > y + \sigma\,\epsilon \\ \frac{1}{2} + \frac{x_i - y}{2\sigma\epsilon} & if\; x_i \in [y - \sigma\,\epsilon, y + \sigma\,\epsilon] \\ 0 & if\; x_i < y - \sigma\,\epsilon\,. \end{cases} \tag{9}$$

Based on Equation (9), Appendix Section A.4 establishes an upper and lower dominance region of very favorable and very unfavorable private signal realizations, respectively, such that the actions of coin holders observing a signal that falls in these regions do not depend on the decisions of others. Specifically, given Assumption 1 there exist two bounds $\underline{x}$ and $\overline{x}$ that define the dominance regions $[\underline{\theta} - \sigma\,\epsilon, \underline{x})$ and $(\overline{x}, \overline{\theta} + \sigma\,\epsilon]$.

**Continuation equilibrium.** Suppose that $x^*_{g+1} \leq x^*_g, \forall g \in \{s, ..., G-1\}$, meaning that coin holders belonging to a group with a higher relative benefit from stablecoins are less inclined to demand conversion. For adoption by at least one and up to $G - (s-1)$ groups, the *critical mass condition* is:

$$\frac{\mu_s m_s \max\{0, \min\{\frac{1}{2} + \frac{x^*_s - \theta^*}{2\sigma\epsilon}, 1\}\} + \Sigma^G_{g=s+1} m_g \max\{0, \min\{\frac{1}{2} + \frac{x^*_g - \theta^*}{2\sigma\epsilon}, 1\}\}}{N} = \hat{A}(\theta^*, x^*_s, ..., x^*_G) = \frac{(\theta^* - 1)r}{\kappa(\theta^* - r)}, \tag{10}$$

where $\mu_s \in (0,1]$ accounts for the fact that the coin holders belonging to group $s$, who have the lowest relative benefit from holding stablecoins, may be indifferent between adopting stablecoins or holding bank deposits, as discussed in Section 3.2.

There are $G - (s-1)$ *indifference conditions*, one equation for stablecoin holders in each group, that depend on the fundamental threshold $\theta^*$ and the group-specific signal thresholds $x^*_s, ..., x^*_G$:

$$E[\Delta_{1,i}(A; \theta^*)|x^*_{g_i = g}] \quad = \quad 0, \forall g \in \{s, ..., G\}. \tag{11}$$

For the general case with multiple groups of coin holders, i.e. $s < G$, the existence of unique equilibrium threshold strategies can be established by adapting the translation argument of Frankel et al. (2003), which has also been used by Garcia and Panetti (2022) to study a Diamond-Dybvig bank run model with wealth heterogeneity across households. Thereafter, I characterize a monotone equilibrium of the continuation game by application of the Belief Constraint of Sákovics and Steiner (2012). The existence of the upper and lower dominance regions assures that $\theta \in (x^*_G - \sigma\,\epsilon, x^*_s + \sigma\,\epsilon)$ holds. Moreover, for $\sigma \searrow 0$ the critical type-specific private signal thresholds fall within a cluster of size $2\sigma\,\epsilon$ together with the equilibrium fundamental threshold $\theta^*$. This cluster collapses to a point for vanishing private signal noise. As a result, the equilibrium is fully determined by the $G-(s-1)$ indifference conditions in (11), which are used to back out $\theta^*$.

The Belief Constraint states that the Laplacian Property holds on average across the different groups of consumers adopting stablecoins, meaning that coin holders' posterior distribution of $A$ is on average uniform over $[0,1]$. This property allows to derive a tractable solution where the equilibrium fundamental threshold is determined by averaging over the indifference conditions, as in Equation (12) below.[19] Importantly, $\theta^*$ is a function of $\overline{\gamma}$, which is the weighted average of the group-specific $\gamma_{g_i}$ terms, a summary statistic for the average payment preference for stablecoins in the population of coin holders, which is governed by $N$. Proposition 1 describes the equilibrium of the conversion game at time 1 for a given adoption rate.

**Proposition 1.** ***(Continuation equilibrium under incomplete information)*** *Given Assumption 1, $\sigma \searrow 0$, a positive level of adoption $N>0$ and a marginal group of adopters $s \in \{1,...,G\}$, there exists a unique monotone equilibrium of the conversion game characterized by threshold strategies where active stablecoin holders in groups $g \in \{s,..,G\}$ demand conversion if and only if they receive a private signal that is below their group-specific signal threshold, i.e. for $x_i \leq x^*_{g_i}$, and where the issuer faces a run at time 1 for all $\theta < \theta^*$, with $\theta^* \in (1, \theta_h)$ given by:*

$$I(\theta^*;N) \equiv [\beta-\alpha-2\overline{\gamma}(N)]\tau_2-\tau_1+\int_{\frac{(\theta^*-1)r}{\kappa(\theta^*-r)}}^{1}\left(1-\frac{\frac{r-\kappa A}{r}\theta^*-\psi}{1-\kappa A}\right)dA=0, \tag{12}$$

*with $\overline{\gamma} \equiv \frac{\mu_s m_s \gamma_s + \Sigma_{g=s+1}^{G} m_g \gamma_g}{\mu_s m_s + \Sigma_{g=s+1}^{G} m_g}$, where $s$ solves $N=\mu_s m_s + \Sigma_{g=s+1}^{G} m_g$, with $\mu_s \in (0,1]$.*

**Proof.** See Appendix Section A.5.1.

#### 3.1.4 Characterization of the Equilibrium Outcome at Time 1

Next, I use the implicit function theorem to characterize the equilibrium described in Equation (12) and to uncover the determinants of fragility. The results are summarized in Proposition 2.

**Proposition 2.** ***(Comparative statics)*** *Given Assumption 1, $\epsilon \searrow 0$ and a positive level of adoption $N>0$ with $s \in \{1,...,G\}$, the probability of stablecoin runs, $Prob\{\theta < \theta^*\}$, depends on the model parameters as shown in Table 2.*
**Proof.** See Appendix Section A.5.2.

The first three comparative static results in Proposition 2 are consistent with findings in the banking literature and give confidence that the proposed model for stablecoins is sensible. Intuitively, an increase in bankruptcy costs and a decrease in the liquidation value $r$ make the issuer

[19]Critically, the application of the Belief Constraint requires that the group-specific terms in the indifference condition are not a function of the aggregate action. This is because the Laplacian property does not hold for the threshold type of a group, but it only holds when averaging over groups. However, the main results can be generalized in a less tractable model with $\kappa=1$ and two groups of coin holders, leading to a dependence of $\alpha_g$ and $\beta_g$ on $A$, and when transaction costs are proportional to the amounts converted.

| Increase in | Probability of a run |
|---|---|
| Bankruptcy cost, $\psi$ | $\uparrow$ |
| Fraction of active coin holders, $\kappa$ | $\uparrow$ |
| Liquidation value, $r$ | $\downarrow$ |
| Conversion cost, $\tau_1$ | $\downarrow$ |
| Average relative preference for stablecoin payments, $\overline{\gamma}$ | $\downarrow$ |

Table 2: Comparative statics

less resilient. Consequently, the issuer faces a higher probability of runs. Similarly, a higher share of active coin holders is destabilizing.

The fourth result states that higher conversion costs have a stabilizing effect. This is because they reduce the incentives to demand conversion. Due to the importance of congestion effects in crypto markets, the stabilizing role of transaction costs appears to be a relevant feature, as a large volume of transactions in a short time window can trigger significant increases in transaction fees. To speak to this phenomenon, I endogenize the conversion cost $\tau_1$ in Section 5.3 and show that its stabilizing effect is strengthened.

**Destabilizing composition effect.** The last comparative static result in Proposition 2 highlights an important *composition effect*. I find that the probability of stablecoin runs decreases with $\overline{\gamma}$, a measure that captures the average payment type and is positively associated with the probability of a consumption preference for seller $\mathcal{A}$, who only accepts payment in stablecoins. Intuitively, coin holders will be less flighty at time 1, if a higher proportion of them are enthusiastic about adoption at time 0. This finding has important implications for the adoption decision, which I discuss next. Corollary 1 summarizes the result formally.

**Corollary 1.** ***(Adoption & fragility)*** *Under the conditions of Proposition 2, the probability of stablecoin runs increases with the adoption rate if higher adoption affects the composition of coin holders, i.e.* $d\theta^*/dN > 0$ *if* $d\overline{\gamma}/dN < 0$*, which holds for* $N \geq m_G$*.*

Corollary 1 highlights an interesting relationship between adoption and stability. When stablecoins attract more consumers from groups with lower levels of $\gamma_g$, then the resulting change in the composition of coin holders is destabilizing. Intuitively, the penetration of wider market segments beyond the crypto enthusiast has implications for the flightiness of the marginal coin holder, thereby affecting the probability of runs. Empirically, the destabilizing composition effect suggest to be most relevant when stablecoins are adopted for new use cases, which may imply a substantial change in the type of the marginal coin holder. Through the lens of the model, such an effect can be captured as a significant drop in $\overline{\gamma}$ when additional groups of consumers start adopting. I will revisit this result in Section 4, where I discuss how adoption and fragility are affected by changes in the environment, such as the introduction of a network externality.

### 3.2 Stablecoin Adoption Game at time 0

The expected differential payoff of consumer $i$ at time 0 from adopting stablecoins instead of bank deposits if she expects an adoption rate $N$ and believes that all active coin holders behave optimally at time 1, that is:

$$a_{1,i}(x_i;N) = \begin{cases} 1 & \text{if } x_i \le x^*_{g_i} \\ 0 & \text{if } x_i > x^*_{g_i}, \end{cases} \tag{13}$$

where $x^*_{g_i} = \theta^*(N)$ solves Equation (12), is given by:

$$\Delta_{0,i} \equiv \int_{\underline{\theta}}^{\theta^*} \left( \kappa(1-\tau_1-\alpha_i\tau_2) + (1-\kappa)\left(\frac{\frac{r-\kappa}{r}\theta - \psi}{1-\kappa} - \beta_i\tau_2\right)\right) \frac{d\theta}{\overline{\theta}-\underline{\theta}} + \int_{\theta^*}^{\overline{\theta}} (1-\beta_i\tau_2)\frac{d\theta}{\overline{\theta}-\underline{\theta}} - (1+r_d-\alpha_i\tau_2). \tag{14}$$

Equation (14) builds on the utility payoffs from Table 1 and the results from Proposition 1. Note that the risk of insolvency only affects stablecoins, as bank deposits are insured. Moreover, for vanishing private signal noise, there is zero probability mass on fundamental realizations that correspond to a partial run, meaning that $A = 1$ for $\theta < \theta^*$ and $A = 0$ for $\theta > \theta^*$. Based on the description of the problems of consumers at time 0 and of coin holders at time 1, we can now define a Perfect Bayesian Nash Equilibrium.

**Definition 1.** *A pure strategy Perfect Bayesian Nash Equilibrium consists of a set of adoption decisions $\{a^*_{0,i}; i \in [0,1]\}$, an adoption rate $N^*$, and a set of conversion decisions $\{a^*_{1,i}(x_i;N); i \in [0,1]\}$ such that:*

1. *Each consumer's adoption decision $a^*_{0,i}$ is optimal at time 0, given $N^*$:*

$$\Delta_{0,i}(N^*) \ge 0 \quad \text{if } a^*_{0,i} = 1$$
$$\Delta_{0,i}(N^*) < 0 \quad \text{if } a^*_{0,i} = 0.$$

2. $N^* = \int a^*_{0,i} di$ .

3. *Active coin holders act optimally at time 1, as per Equation (13), where $\theta^*(N^*)$ solves Equation (12).*

Condition *(1.)* and *(3.)* require that adoption and conversion choices are sequentially rational at time 0 and time 1, as prescribed in Equation (13), given the beliefs. Condition *(2.)* requires consumer to follow equilibrium strategies. I proceed by first discussing the beneficial role of stablecoins in Section 3.2.1 to highlight the advantage of having the "right money on hand" at time 2 for versions of the model where stablecoins are arbitrarily safe. Thereafter, Section 3.2.2 derives the optimal stablecoin adoption decision for the general model and studies the interaction between the fragility and the optimal adoption decision.

### 3.2.1 Transaction Costs and the Beneficial Role of Stablecoins

The uncertain payment type combined with transaction costs makes the consumer problem at time 0 non-trivial. To see this, I first consider the limiting case $\tau_2 \searrow \tau_0 = 0$, where the advantage from having the "right money on hand" at time 2 vanishes and holding deposits is the dominant strategy. Second, I consider the limiting case $r, \underline{\theta} \nearrow 1$, where the liquidation cost vanishes and stablecoins are safe, to illustrate how positive transaction costs create a trade-off for consumers when they decide whether or not to adopt stablecoins. In the first case with $\tau_2 \searrow 0$, it is optimal for consumers in the adoption game to keep their bank deposits, i.e. $a^*_{0,i} = 0$. To see this, observe that the expected payoff from holding deposits, $1 + r^D - \alpha_i \tau_2 \approx 1 + r^D$, exceeds the expected return of stablecoins, which is (weakly) smaller than one due to the risk of insolvency.

The second case with $r, \underline{\theta} \nearrow 1$ considers the limiting case where stablecoins are safe. Given a positive transaction cost, $\tau_2 > 0$, some consumers may now find it optimal to adopt stablecoins to benefit from transaction cost advantages, especially when stablecoin payments are likely to be accepted at time 2 and when the risk of a devaluation of the stablecoins is low. The benchmark with safe stablecoins serves to illustrate this point. Intuitively, the limit $\underline{\theta} \nearrow 1$ ensures that the issuer will be able to exchange coins at time 2 at a rate that is arbitrarily close to the one-to-one conversion promise, as long as there are no redemption requests at time 1. Moreover, the limit $r \nearrow \underline{\theta} \approx 1$ ensures that the issuer can do so even if there are redemption requests, because her liquidation cost is arbitrarily small. Formally, $\theta^* = \underline{\theta}$ and the probability of a stablecoins run is zero. This benchmark best captures an "ideal world" where stablecoins are tightly regulated and backed by central bank reserves, while offering a technology-enabled access to certain use cases or benefits for consumers that are otherwise unavailable.[20]

Proposition 3 summarizes the solution to the game. As before, $s \in \{1, .., G\}$ is defined as the marginal group of adopters who have the lowest benefit from adoption.

**Proposition 3.** ***(Safe stablecoins)*** *Let $r \to \underline{\theta}$, $\underline{\theta} \to 1$ and $\tau_1/\tau_2 > \beta - \alpha$. Each consumer i optimally chooses:*

$$a^*_{0,i} = \begin{cases} 1 & if\ r^D < [\alpha_i - \beta_i]\tau_2 \\ \in \{0,1\} & if\ r^D = [\alpha_i - \beta_i]\tau_2 \\ 0 & if\ r^D > [\alpha_i - \beta_i]\tau_2 \end{cases} \tag{15}$$

*at time 0, and active coin holders optimally keep their stablecoins at time 1, $a^*_{1,i} = 0, \forall i$. A necessary and sufficient condition for a positive demand for stablecoins at time 0 is given by $r^D/\tau_2 < \alpha_G - \beta_G$, and there exists a unique marginal group of stablecoin adopters $s^* = s \in \{1, .., G\}$. If $\alpha_s - \beta_s > r^D/\tau_2 > \alpha_{s-1} - \beta_{s-1}$, the equilibrium stablecoin adoption rate is uniquely determined as $N^* = \Sigma^G_{g=s^*} m_g$. Instead, if $r^D/\tau_2 = \alpha_s - \beta_s$, then $N^* \in [\Sigma^G_{g=s^*+1} m_g, \Sigma^G_{g=s^*} m_g]$.*

[20] In addition, the benchmark will serve as a basis for discussing in Section 5 regulated e-money providers, narrow banks and a hybrid CBDC through the lens of the model.

**Proof.** See Appendix Section A.5.3.

Proposition 3 states that a positive adoption rate requires that there are at least some *crypto enthusiasts*, e.g. consumers belonging to group $G$, who have a sufficiently high probability of having a preference for seller $\mathcal{A}$ such that they find it attractive to adopt stablecoins despite the lower interest rate. Moreover, the marginal group of adopters $s^*$ is unique and there also exists a unique solution to the adoption game if no group of consumers is exactly indifferent between adopting stablecoins and holding bank deposits.

In a richer model, consumers may also enjoy a benefit from holding stablecoins/bank deposits, which is potentially influenced by network effects (Section 4.1.2), or interest income from stablecoin lending (Section 5). Therefore, the beneficial role of stablecoins extends beyond reducing transaction costs. Moving away from the special case with safe stablecoins, I will next focus on the practically more relevant version of the model, where the issuer is susceptible to runs.

#### 3.2.2 Equilibrium in the Adoption Game and the Role of Beliefs about Fragility

Observe that the differential expected utility payoff from adopting stablecoins in Equation (14) is strictly decreasing in $\theta^*$ and strictly increasing $\gamma_{g_i}$. Hence, under the conditions of Proposition 2, there exists at most one value $\tilde{\gamma} \in [\gamma_1, \gamma_G]$ such that all consumers with $\gamma_g \geq \tilde{\gamma}$ adopt stablecoins, while all consumers belonging to groups with $\gamma_g < \tilde{\gamma}$ favor insured bank deposits. Lemma 1 summarizes the key insights.

**Lemma 1.** ***(Fragility & adoption)*** *Under the conditions of Proposition 2 and given a belief about the probability of stablecoin runs, i.e. about $\theta^*$, the adoption rate $N$ solving the stablecoin adoption game is weakly decreasing in $\theta^*$ and the weighted average of the group-specific $\overline{\gamma}$ is weakly increasing in $\theta^*$.*

In conjunction with Corollary 1, Lemma 1 establishes the interplay between stablecoin adoption and fragility. Lemma 1 states that a less favorable believe about the probability of runs, i.e. a higher level of $\theta^*$, is associated with a lower adoption rate, i.e. a lower $N$, and with a composition effect that lowers the weighted average of the group-specific $\overline{\gamma}$. Conversely, Corollary 1 states that a lower adoption rate is associated with a lower probability of runs. In equilibrium the belief about $\theta^*$ in the adoption game at time 0 and the solution $N^*$ have to be consistent with the $\theta^*$ solving the conversion game at time 1 and the implied $\overline{\gamma}$.

It remains to analyze the existence of an equilibrium with adoption. To ease the analysis, I assume that there exists a (virtual) group $v$ of consumers with $\gamma_v = \tilde{\gamma}$ and $m_v \geq 0$ that is just indifferent between adopting stablecoins or deposits, meaning that $\Delta_{i,0}(\theta^*) = 0$ for $g_i = v$. Consequently, $\tilde{\gamma}$ denotes the smallest possible level of the payment type parameter governing among the group of coin holders and $\gamma_v \leq \gamma_s$. Next, I analyze necessary and sufficient conditions for the existence of an interior solution where all consumers belonging to groups $g \in \{s, G\}$ with $s \geq 1$ adopt stablecoins, while all others keep their funds in deposits, i.e. $\gamma_G \geq \tilde{\gamma} > \gamma_1$.

Suppose that $s = G$ and $N = m_G$. From the differential payoff in Equation (14) the corresponding choices, $a_{0,i} = 1$ if $g_i = G$ and $a_{0,i} = 0$ if $g_i < G$, are optimal for consumers if $\Delta_{0,i}(\theta^*(\bar{\gamma}), \gamma_G) \geq 0$ where $\theta^*$ solves (12) for $s = G$ and $\bar{\gamma} = \gamma_G$, while $\Delta_{0,i}(\theta^*(\bar{\gamma}), \gamma_{G-1}) < 0$. Instead, if $\Delta_{0,i}(\theta^*(\bar{\gamma}); \gamma_{G-1}) \geq 0$ where $\theta^*$ solves Equation (12) for $s = G-1$ and some $\bar{\gamma} \in [(m_{G-1}\gamma_{G-1} + m_G\gamma_G)/(m_{G-1} + m_G), \gamma_G])$, then I follow an iterative process to determine $s \leq G-1$. Given that the equilibrium fundamental threshold $\theta^*$ solving the conversion game is continuous in $\bar{\gamma}$ and monotonically decreasing when groups of stablecoin adopters with a lower $\gamma_g$ are added (Proposition 2), an interior solution to the adoption game with $s \in \{1, G\}$ and $N^* \in (0,1)$ exists if two conditions are met jointly: *(1)* $\Delta_{0,i}(\theta^*(\gamma_G), \gamma_G) > 0$ where $\theta^*$ solves (12) for $s = G$ and *(2)* $\Delta_{0,i}(\theta^*(\bar{\gamma}), \gamma_1) < 0$ where $\theta^*$ solves (12) for $s = 1$ and $\bar{\gamma}$ is evaluated at $N = 1$. This is because no consumer adopts stablecoins if the first condition is violated and all consumers adopt stablecoins if the second condition is violated. For $\theta > \theta_h$ the lower bound for the weak preference from adopting stablecoins is given by $\underline{\gamma} \equiv (r^D + (\beta - \alpha)\tau_2)/(2\tau_2)$. This verifies that for all coin holders there is indeed no benefit from demanding conversion at time 1 if the stablecoin issuer is known to be solvent, i.e. $\gamma_s \geq \underline{\gamma}$, which is a result that is also used in the analysis of Section 3.1.2. The described solution to the adoption game is unique. Proposition 4 summarizes.

**Proposition 4.** ***(Equilibrium of the adoption game)*** *Suppose active stablecoin holders follow threshold strategies in the time* 1 *conversion game. Under the conditions of Proposition 2, there exists a unique solution to the stablecoin adoption game at time* 0*. The equilibrium is characterized by* $N^* = 0$ *if* $\Delta_{0,i}(\theta^*(\bar{\gamma} = \gamma_G), \gamma_G) < 0$ *and by* $N^* = 1$ *if* $\Delta_{0,i}(\theta^*(\bar{\gamma}(N = 1)), \gamma_1) > 0$*. Moreover, if both conditions are violated, there exists a unique equilibrium with* $N^* \in (\Sigma_{g=s+1}^{G} m_g, \Sigma_{g=s+1}^{G} m_g + m_s]$*, where all consumers belonging to groups* $g \geq s$ *with* $\gamma_g > \tilde{\gamma}$ *optimally adopt stablecoins and all consumers belonging to groups* $g < s$ *with* $\gamma_g < \tilde{\gamma}$ *do not adopt stablecoins, while consumers belonging to group* $s$ *are indifferent if* $\gamma_s = \tilde{\gamma}$*.*

Having established the existence of a unique equilibrium of the two-stage game, I proceed with the policy analysis, first for the baseline model and then for versions of the model that include additional features of the stablecoins market.

# 4 Policy Analysis

Section 4.1 addresses regulatory concerns regarding a widespread, rapid, and from a social welfare perspective "excessive" adoption of stablecoins. Specifically, I conduct an efficiency analysis that focuses on differences in the privately and socially optimal levels of adoption. Thereafter, Section 4.2 speaks to regulatory concerns about moral hazard and the disclosure of risks in a version of the model where the issuer can select the portfolio risk.

## 4.1 Efficiency Analysis: Excessive Adoption

I identify two mechanism that can lead to excessive stablecoin adoption through the lens of the model. Section 4.1.1 discusses the implications of an uninternalized destabilizing composition effect and Section 4.1.2 discusses the implications of an uninternalized erosion of the value of bank deposits for a version of the model with an adoption externality.

### 4.1.1 Uninternalized Destabilizing Composition Effect

The uninternalized destabilizing composition effect builds on the link between adoption and fragility established in Corollary 1. Formally, let $N^*$ denote the market equilibrium and $N^{SP}$ the solution of a constrained planner, who takes the one-to-one conversion promise as given and can only choose the adoption rate. Adoption is classifed as "excessive" if $N^* > N^{SP}$. Proposition 5 summarizes the first efficiency result.

**Proposition 5.** ***(Excessive adoption: uninternalized destabilizing composition effect)*** *Under the conditions of Proposition 2, the equilibrium level of adoption is excessive relative to the constrained efficient level of adoption, $N^* > N^{SP}$, whenever the destabilizing composition effect is present. Otherwise, $N^* = N^{SP}$.*

**Proof.** See Appendix Section A.5.4.

Intuitively, an inefficiently high level of stablecoin adoption can arise, because the marginal adopter of stablecoins at time 0 does not take into account that she poses a negative externality on other coin holders by increasing the probability of a stablecoin run due to the destabilizing composition effect, i.e. $dProb\{\theta < \theta^*\}/dN > 0$. Since the distribution of groups is discrete, it takes more than one group of adopters for the destabilizing composition effect of Corollary 1 to arise.

From a regulatory perspective, the "Tether scenario" is best captured by excessive adoption resulting from the destabilizing composition effect. If Tether is widely adopted for new use cases, and this significantly changes the incentives of the marginal coin holder, then there is a concern that this will lead to a noticeable shift in the average flightiness of coin holders, fueled by excessive adoption. An example could be the wider adoption of Tether for remittances, which leads to large volumes of parked funds that may be converted more quickly after negative information about the issuer, compared to the funds held by retail crypto enthusiasts (or early adopters) who use stablecoins as a vehicle to reduce the cost of trading in the crypto universe.

### 4.1.2 Uninternalized Erosion of Bank Deposits

Facebook's announcement in June 2019 to launch its own digital currency was a wake-up call for central banks and financial regulators. As discussed in the introduction, a key concern for policy makers in the "Facebook Libra scenario" is that stablecoins are adopted very rapidly, with important implications for the payments landscape and for banks, which could suffer a significant loss of stable retail deposit funding and a reduction in the attractiveness and service value of deposits.

Building on Section 4.1.1 I study the effect of an uninternalized erosion of the value of deposits in a version of the model with an externality that originates from a dependency of the common components of the probabilities $\alpha$ and $\beta$ to have a consumption preference for sellers $\mathcal{A}$ and $\mathcal{B}$

from the adoption rate $N$. Formally, I assume that $\alpha'(N), \beta'(1-N) \geq 0$, which can be interpreted as an increase (decrease) in the desire of consumers to consume the goods from seller $\mathcal{A}$ ($B$) when the economy-wide adoption of stablecoins is higher. This could, for instance, be rationalized by more consumption goods (such as internet services) shifting to sellers who accept, or even prefer, payment in stablecoins, when the economy-wide adoption of stablecoins is higher.[21]

Section 5.1 discusses how the analysis of the equilibrium of the two-stage game is altered with the introduction of the adoption externality. Proposition 6 summarizes the efficiency result.

**Proposition 6.** ***(Excessive adoption: uninternalized erosion of deposits)*** *Under the conditions of Proposition 2, let $\beta' = 0, \forall N \in [0,1]$ and $\alpha(N) \equiv \chi N$ with $\chi > 0$ and $\chi \searrow 0$, then the equilibrium level of adoption, $\check{N}^*$, is excessive relative to the constrained efficient level of adoption, i.e. $\check{N}^* > \check{N}^{SP}$, whenever there is an interior solution to the adoption game, i.e. $\check{N}^* \in (\Sigma_{g=j}^{G} m_g, \Sigma_{g=j-1}^{G} m_g)$. Moreover, the magnitude of the inefficiency increases if the adoption externality is introduced alongside the uninternalized destabilizing composition effect.*

**Proof.** See Appendix Section A.5.5.

Focusing on the case with $\alpha' > 0$ and $\beta' = 0, \forall N \in [0,1]$ allows to determine how the emergence of a second externality increases the magnitude of the inefficiency identified in Proposition 5 by increasing the wedge between the market equilibrium and the constrained efficient allocation. Notably, the proposition restricts attention the limiting case $\chi \searrow 0$, which assures that Inequality (19) holds and the solution to the adoption game is unique (Proposition 4). This facilitates a clear comparison between the market allocation and the solution to the constrained planner problem. However, the result in Proposition 6 suggests to hold more generally, as long as $\beta(1-N)$ is not too sensitive to changes in the adoption rate.

It is worth reiterating that the aim of Sections 4.1.1 and 4.1.2 is not to conduct a full welfare analysis, but to rationalize a regulatory concern by identifying two mechanisms that can give rise to excessive stablecoin adoption. Depending on the forces at play, adoption must not be excessive. For instance, consumers may coordinate on the efficient level of adoption if there is a strong adoption externality operating through $\beta$.

## 4.2 Disclosure and Moral Hazard

The regulatory discussion on both sides of the Atlantic (US 2021; EU 2022) emphasizes measures to increase transparency about the asset holdings of stablecoin issuers (recall Table A2) and to reduce the riskiness of the assets that back the stablecoins. To speak to this debate, I analyze a model extension with a moral hazard problem to study the issuer's incentives for risk-shifting and

[21]While a micro-foundation of the network externality and a full-fledged welfare analysis are beyond the scope of this paper, one could consider a matching process in which consumer surplus depends on the number of sellers, which, in turn, depends on the adoption rate (see, e.g., Rochet and Tirole (2003)). What matters is that the erosion of the value of bank deposits is not internalized.

the role of disclosure. My starting point is the baseline model from Sections 3.1 and 3.2, to which I add a classic risk-shifting problem at time 0 by allowing the issuer to select a parameter, which governs the riskiness of the portfolio after collecting the funds from stablecoin adopters.

Formally, I consider the choice $x \in \{x_H, x_L\}$, where $x_H = 0$ and $x_L \in (0,1)$ are the high risk and low risk portfolio choices, respectively. The modified fundamental distribution follows $\theta \in U[\underline{\theta}(x), \overline{\theta}(x)]$, with $\theta(x) \equiv xR + (1-x)\theta$, $\underline{\theta}(x) \equiv xR + (1-x)\underline{\theta}$ and $\overline{\theta}(x) \equiv xR + (1-x)\overline{\theta}$. An interesting case to consider is $R = (\overline{\theta} + \underline{\theta})/2$, where the fundamental distribution under $x = x_H$ is a mean-preserving spread of the distribution under $x = x_L$. Moreover, I assume that the issuer receives a payoff of $\check{r}(x) \equiv x r_L + (1-x) r$ if she divests prematurely at time 1, with $r_L \in [r, 1]$. Consequently, the low risk choice is weakly favorable when it comes to divestments, i.e. $\check{r}(x_L) \geq \check{r}(x_H) = r$.

**Remark.** ***(Socially optimal portfolio choice)*** *The low risk portfolio choice $x = x_L$ is associated with a strictly higher social welfare than the high risk portfolio choice $x = x_H$ under the sufficient condition that the probability of stablecoin runs is weakly smaller under the consumers' belief that $x = x_L$, i.e. if $\theta^*(x_L) = \theta^* \leq \theta^*(x_H)$.*

A lower probability of runs is associated with a higher welfare because of the reduction in costly divestments at time 1. I will argue below that $\theta^*(x_L) \leq \theta^*(x_H)$ always holds. While the low risk portfolio choice is socially desirable, the preference of the issuer may differ. Moreover, her risk choice may not be observable and verifiable. In Section 4.2.1 I analyze the case where the issuer can commit to a risk choice. This allows to highlight a potential misalignment stemming from the trade-off between the benefit of enjoying a higher upside from selecting $x_H$ in case of solvency and the benefit of a potentially lower probability of runs from selecting $x_L$. Thereafter, Section 4.2.2 analyzes the case without commitment, where a moral hazard problem emerges. Finally, Section 4.2.3 discusses implications for regulation and the role of disclosure.

### 4.2.1 The Case With Commitment

Suppose that the issuer announces her choice $x \in \{x_L, x_H\}$ before the stablecoin adoption game and that the announcement is credible, meaning that the funds from stablecoin adopters at $t = 0$ are invested in a portfolio with a riskiness governed by the previously announced $x$.

For the choice $x = x_H$ the analysis in Sections 3.1 and 3.2 applies. For the choice $x = x_L$ the conversion game is altered as follows. First, the parameter conditions in Assumption 1 need to be modified to account for the change in the upper and lower bounds of the fundamental, as well as for the lower return when divesting prematurely. Second, the modified equilibrium condition in Equation (12) of Proposition 1 reads:

$$[\beta - \alpha - 2\overline{\gamma}(x,N)]\tau_2 - \tau_1 + \int_{\frac{(\theta^*-1)\check{r}(x)}{\kappa(\theta^*-\check{r}(x))}}^{1} \left(1 - \frac{\frac{\check{r}(x)-\kappa A}{\check{r}(x)}\theta^* - \psi}{1-\kappa A}\right) dA = 0, \tag{16}$$

where $\overline{\gamma}$ depends on the announced $x$, as well as the $N$ determined in the adoption game at time 0. Recall from Proposition 2 that $d\theta^*/dr < 0$. Provided $\check{r}(x_L) > r$, this direct effect is associated with a lower fundamental threshold $\theta^*$ solving Equation (16) under $x_L$ instead of $x_H$. As a result, the choice of $x_L$ is stabilizing for a given $N$ and $\overline{\gamma}$ if $\check{r}(x_L) > r$, which increases the resources available if the issuer is insolvent at time 2.

Next, I move to the stablecoin adoption game at time 0. In addition to the stabilizing effect established previously, there is a second effect that originates from the less dispersed fundamental distribution under $x_L$, i.e. $\underline{\theta} < \underline{\theta}(x_L)$ and $\overline{\theta}(x_L) < \overline{\theta}$. Under which condition is this second effect also stabilizing? First, note that the $\theta^*(x)$ solving Equation (16) does not depend on the bounds of the fundamental distribution. By taking the derivative with respect to $x$, it can be shown that the ex-ante probability of the stablecoin issuer to be insolvent is strictly decreasing in $x$ under the sufficient condition that $\theta^*(x_L) < R$, which holds if the probability of runs against the issuer is sufficiently low – formally if $Prob\{\theta < \theta^*\} < 1/2$.

It remains to discuss the response of $N$, as well as the associated change in $\overline{\gamma}$. Given Lemma 1, a more favorable belief about stability, i.e. a lower $\theta^*$, is associated with a weakly higher adoption rate. The same is true if the payoff from divesting at time 1 is increased. A higher adoption rate, in turn, has a destabilizing effect. In equilibrium, such an indirect destabilizing effect must, however, be dominated by the direct stabilizing effects. Taken together, the overall effect of selecting $x_L$ instead of $x_H$ is associated with a weakly lower probability of stablecoin runs under the sufficient condition that $Prob\{\theta < \theta^*\} < 1/2$, which can be regarded as not restrictive. After all, a too high probability of runs would preclude adoption.

Next, I contrast the issuer's benefit of a potentially lower probability of stablecoin runs when selecting $x_L$ with the issuer's benefit of enjoying a higher upside when selecting $x_H$. The issuer's expected payoff is:

$$\pi(x) = \int_{\underline{\theta}(x)}^{\theta^*(x,\check{N}^*)} \frac{0}{\overline{\theta}(x) - \underline{\theta}(x)}\, d\theta + \int_{\theta^*(x,\check{N}^*)}^{\overline{\theta}(x)} \frac{\theta - 1}{\overline{\theta}(x) - \underline{\theta}(x)} \check{N}^*(x,\theta^*)\, d\theta, \tag{17}$$

where $\check{N}(x,\theta^*)$ denotes the adoption rate given $x$. Note that $\pi > 0$, $\forall \check{N}(x,\theta^*) > 0$ since $\theta^* \leq \theta_h < \overline{\theta}$ by definition. The differential expected payoff from selecting $x = x_L$ is:

$$\begin{aligned} \pi(x_L) - \pi(x_H) &= \int_{\theta^*(x_L)}^{\overline{\theta}(x_L)} (\theta - 1)\check{N}^*(x_L,\theta^*(x_L))\, \frac{d\theta}{\overline{\theta}(x) - \underline{\theta}(x)} - \int_{\theta^*}^{\overline{\theta}} (\theta - 1) N^*\, \frac{d\theta}{\overline{\theta} - \underline{\theta}} \\ &= \underbrace{\int_{\theta^*(x_L)}^{\theta^*} (\theta - 1)\frac{\check{N}^*(x_L,\theta^*(x_L))}{\overline{\theta}(x_L) - \underline{\theta}(x_L)}\, d\theta}_{\substack{\text{benefit of weakly} \\ \text{fewer runs if } x = x_L}} + \underbrace{\int_{\theta^*}^{\overline{\theta}(x_L)} (\theta - 1)\left(\frac{\check{N}^*(x_L,\theta^*(x_L))}{\overline{\theta}(x_L) - \underline{\theta}(x_L)} - \frac{N^*}{\overline{\theta} - \underline{\theta}}\right) d\theta}_{\substack{\text{benefit of a less dispersed fundamental} \\ \text{and weakly higher adoption if } x = x_L}} - \underbrace{\int_{\overline{\theta}(x_L)}^{\overline{\theta}} (\theta - 1)\frac{N^*}{\overline{\theta} - \underline{\theta}}\, d\theta}_{\substack{\text{cost of a lower} \\ \text{upside if } x = x_L}}. \end{aligned} \tag{18}$$

Whether or not it is optimal for the issuer to select $x_L$ depends on the relative strength of the three effects in Equation (18). Intuitively, a lower sensitivity of the probability of runs and of adoption to a change in the riskiness of the investment portfolio are more likely to incentivize the issuer to select $x_H$. To make this point, I construct an existence result by showing that $\pi(x_L) - \pi(x_H) < 0$ for $x_L \searrow 0$ in case adoption is locally insensitive to change in the riskiness. Proposition 7 summarizes.

**Proposition 7.** ***(Privately and socially optimal portfolio choices under commitment)*** *The privately optimal portfolio choice can differ from the socially optimal portfolio choice $x^{SP} = x_L$ even if the stablecoin issuer can commit. An example for $x^* = x_H < x^{SP}$ arises for $x_L \searrow 0$ if the adoption rate is locally unaffected by changes in $x$, i.e. if $\gamma_s > \tilde{\gamma}$.*

**Proof.** See Appendix Section A.5.6.

Intuitively, the example for $x^* = x_H < x^{SP}$ described in Proposition 7 emerges because the low risk portfolio $x_L$ involves forgoing a part of the upside in Equation (18), without generating benefits in terms of a higher adoption or a lower probability of runs. This is because $\check{N}^* = N^*$ if $\gamma_s > \tilde{\gamma}$, which implies that $\theta^*(x_L) = \theta^*$.

While the result of Proposition 7 for the limiting case $x_L \searrow 0$ continues to hold as long as the response of $\check{N}^*$ and $\theta^*$ to changes in the portfolio risk is not too strong, it is not robust to the introduction of fierce competition among multiple issuers. Assuming a contestable market, new entrants can credibly announce their risk and compete by setting $x$. This results in an outcome that maximizes consumer welfare. Thus, barriers to entry, such as switching costs, suggest to play a significant role in creating a wedge between the privately and socially optimal portfolio choice.

The misalignment between the privately and socially optimal portfolio choice is also less likely to occur if the monopolistic issuer has additional skin in the game, which could, for instance, stem from future transaction fee income (Section 5.4), or from the affiliation of a stablecoin issuer with a cryptocurrency exchange. In practice, USD Coin and the exchange Coinbase or Binance Coin and the exchange Binance are two such cases. A crypto exchange experiences a significant disruption and possibly risks bankruptcy if its affiliated stablecoin is devalued. Consequently, the stablecoin issuance policy is likely to be more prudent. The self-reported asset breakdowns published by issuers suggest that this conjecture can be verified; in October 2022 USD Coin and Binance Coin claim to be exclusively backed by U.S. government guaranteed debt instruments, which stands in stark contrasts to the more risky investments by Tether USD (see Table A2), a stablecoin that is not owned by a crypto exchange. Corollary 2 develops the insight formally.

**Corollary 2.** ***(Skin in the game)*** *Suppose the stablecoin issuer incurs an extra disutility, $d > 0$, from bankruptcy. Then $\exists \underline{d} > 0$, such that $x^* = x^{SP}$ for $x_L \searrow 0$ if $d > \underline{d} > 0$.*

Intuitively, the privately and socially optimal portfolio choice are less likely to differ if the issuer has additional skin in the game, which I introduce with an additive disutility term $d$ in (17).

### 4.2.2 The Case Without Commitment

Next, I consider the case where the issuer cannot commit to a portfolio risk choice. Specifically, I assume that the issuer's announcement of $x$ before the stablecoin adoption game is not credible and the chosen riskiness of the portfolio cannot be observed or verified by consumers. It can be shown by contradiction that the issuer optimally selects $x^* = x_H$, as the choice of $x$ does not affect the adoption rate and the beliefs of coin holders at time 1, who correctly belief that the issuer selects $x_H$. Proposition 8 summarizes.

**Proposition 8.** ***(No commitment)*** *The privately optimal portfolio choice under no commitment is* $x^* = x_H$.

### 4.2.3 Implications for Regulation

From a policy viewpoint, the previous results bear relevance for the ongoing discussion about the adequate regulation of the stablecoins market. The lack of transparency by issuers about the quality of the assets backing the stablecoins and weak disclosure standards (that largely rely on self-reported information that cannot be verified) are high on the list of policy concerns (US 2021; Bains et al. 2022). If the issuer is unable to commit to a portfolio risk choice, then a classical moral hazard problem emerges with potentially large incentives to select a high risk portfolio (Proposition 8). The announcement of a portfolio risk choice by the issuer or self-reported information about the riskiness of the portfolio are not credible. Financial regulators may help to address the moral hazard problem by introducing an adequate regulatory disclosure regime that allows issuers to obtain a public verification of statements about their assets that enhances credibility.

However, such a regulatory disclosure regime is unlikely to be enough. Given the potential misalignment of the privately and socially optimal portfolio risk choice (Proposition 7), the introduction of a disclosure regime can be insufficient in achieving the socially optimal level of risk even if it allows issuers to credibly communicate. In light of the high market concentration (see Figure 1), also inadequate competitive pressures and entry barriers may hinder the implementation of the socially optimal risk choice, as discussed earlier.

To hold undesirable risk-taking in check, effective regulatory measures must directly influence the issuer's portfolio decisions. This involves imposing specific requirements on reserve assets' quality, liquidity, and diversification, as well as the management of custodial risks. In addition, the issuer's capitalization plays a critical role. Capital requirements not only provide a buffer against losses but also increase the issuer's skin in the game, which is conducive to the implementation of the efficient level of risk (Corollary 2).

## 5 Additional Insights for Risk Assessment, Extensions and Robustness

In this section I discuss several extensions to the model and the robustness of the main findings. First, Sections 5.1 and 5.2 consider two relevant aspects of the stablecoins market that can promote adoption and potentially also reduce the fragility of stablecoins: network effects and stablecoin lending. Subsequently, Section 5.3 discusses the stabilizing role of congestion effects leading to an endogenous response of conversion costs. Then Section 5.4 considers the resilience of the issuer, introducing fixed costs and revenue from transaction fees. Thereafter, Section 5.5 discusses e-money providers, narrow banks and a hybrid CBDC through the lens of the model. Finally, Section 5.6 covers alternative model specifications and robustness.

## 5.1 Network effects, adoption and fragility

In this Section I analyze in more detail the version of the model with a network effect that takes the form of the adoption externality introduced in Section 4.1.2, where $\alpha'(N), \beta'(1-N) \geq 0$. Importantly, the adoption externality counteracts the destabilizing composition effect. Starting with the continuation equilibrium at time 1 for a given adoption rate $N$, I revisit the destabilizing decomposition effect established in Corollary 1.

**Corollary 3.** ***(Adoption & fragility revisited)*** *The result in Corollary 1 prevails, as long as the destabilizing composition effect from new adopters with a lower $\gamma_g$ is not outweighed by positive network effects:*

$$\frac{d\theta^*}{dN} > 0 \text{ iff } \frac{d[\beta(1-N) - \alpha(N) - 2\overline{\gamma}]}{dN} > 0 \tag{19}$$

*where:*

$$-\frac{d[\beta(1-N) - \alpha(N) - 2\overline{\gamma}]}{dN} = \overbrace{\frac{\Sigma_{g=j}^{G} m_g(\gamma_{j-1} - \gamma_g)2}{\left(\mu_{j-1} m_{j-1} + \Sigma_{g=j}^{G} m_g\right)^2}}^{<0;\ \textit{negative composition effect}} + \overbrace{\alpha'(N) - \beta'(1-N)}^{>0;\ \textit{positive network effect}},$$

*with $j = s+1$ if $\mu_s \in [0,1)$ and $j = s$ if $\mu_s = 1$.*

Moving to the adoption game at time 0, it can be shown that the solution to the adoption game remains unique if Inequality (19) holds for all $N > 0$, so that the destabilizing decomposition effect is mitigated, but still dominates. In this case, the adoption rate increases, since:

$$\frac{d\Delta_{0,i}}{d\alpha}\frac{d\alpha}{dN}\Big|_{N^*} + \frac{d\Delta_{0,i}}{d\beta}\frac{d\beta}{dN}\Big|_{N^*} > 0,$$

where $d\theta^*/d\alpha < 0$ and $d\theta^*/d\beta > 0$ follow from the Proof of Proposition 2. Therefore, network effects promote adoption and reduce fragility by making stablecoins more attractive.

Notably, the equilibrium analysis is more complicated when Inequality (19) is violated, since different optimal adoption decisions can be consistent with different beliefs about the issuer's fragility, which introduces a belief-driven feed-back between stablecoin adoption and stability that can cause sudden shifts in the adoption rate. See Appendix Section A.8 for a discussion. Next, Section 5.2 considers a version of the model with stablecoin lending, another relevant feature of the stablecoins market that can promote adoption.

### 5.2 Stablecoin Lending and the Role of a Large Speculator

Stablecoin lending is a recent phenomenon that has become a booming corner of the crypto market in 2022. It is dominated by a handful of new intermediaries such as Crypto.com, BlockFi.com and Nexo.io, who offer crypto savings accounts and crypto loans. Crypto savings accounts are offered to retail customers, who can typically choose between overnight and term deposits of up to 3 months duration. There is a also a futures market. Crypto borrowers may have different motives, ranging from the need for liquidity to conduct trades in the crypto universe or to process crypto payments, to the desire to short crypto. Importantly, stablecoin lending can be used by large institutional traders to bet on the devaluation of a stablecoin, much like currency speculation in the foreign exchange market. Not surprisingly, a wave of redemptions by speculators who borrowed stablecoins suggests to have contributed to the collapse of USD Terra in May 2022.[22]

In this section I consider an extension with stablecoin lending, where consumers can earn interest by lending out their stablecoins during the game, but they also face the risk that their coins are devalued by the time they are return by the borrower. Specifically, I introduce a large borrower of stablecoins who may have a speculative motive. The borrower is unconstrained and risk-neutral. She wants to borrow $\delta \in (0, \kappa N)$ units of the stablecoin at the end of time 0 from coin holders with the promise to return $(1 + r_\ell)\delta$ coins at time 2, where $r_\ell > 0$ denotes the interest rate offered to lenders. There are two states of the world: $z = 1$ and $z = 2$. In state $z = 1$ the borrower turns out to be a speculator and in state $z = 2$ she does not to have a speculative motive. The probability of state $z = 1$ is $0 \leq q < 1$ and the probability of state $z = 2$ is $1 - q$. At time 0 the borrower's motive is unknown, but the probabilities of the two states are common knowledge.

In case the borrower has a speculative motive, she demands conversion at the beginning of time 1 before the fundamental is realized and before the remaining coin holders play the stablecoin conversion game. This allows her to gain from a subsequent devaluation. She does, however, incur a loss in case the issuer remains solvent and there is no devaluation. The associated payoffs are typical for a currency speculator.

In case the borrower does not have a speculative motive, she keeps the coins till time 2 independent of the fundamental realization. This behavioral assumption could be rationalized by the inability of the borrower to learn about $\theta$ in conjunction with an unmodeled benefit (or service value) from holding stablecoins in-between time 0 and 2, which is generating her demand for borrowing stablecoins at time 0 and could, for instance, be rationalized by a need for liquidity to conduct trades or for collateral to process payments.

For simplicity, I assume that the borrower's action is observed by all coin holders before they

[22]In the case of USD Terra the issuer of the stablecoin and it's underlying crypto asset Luna, as well as the USD Terra lending platform Anchor were intertwined. The model of stablecoin lending in this paper maps better to the leading stablecoins, which are mostly backed by traditional financial assets and where the issuers do not run the stablecoin lending market.

play the conversion game. All this is taken into account by consumers when they play the stablecoin conversion game at time 1, the lending game at the end of time 0 and the adoption game at the beginning of time 0. A destabilizing effect of stablecoin lending arises when the borrower is a speculator and demands conversion of the $\delta$ coins in her possession, which forces the issuer to divest assets. Consequently, the issuer has fewer resources available in the subsequent conversion game. Instead, a stabilizing effect arises when the borrower is not a speculator and does not demand conversion (while the coin holders who lent to her at time 0 may have demanded conversion at time 1). In this case the borrower provides partial insurance against runs, which makes the remaining coin holders less flighty. The differential effect of stablecoin lending on fragility across the two states increases in the borrower's size, i.e. in $\delta$, meaning that only a large speculator matters.

The game shares similarities with the currency attack model of Corsetti et al. (2004). Unlike Corsetti et al., I abstract from signaling by a better informed speculator who can matter even if small in size. In a recent paper, Gorton et al. (2022b) offer a rationale based on stablecoin lending that explains why there can be a demand for stablecoins even though there is a risk of runs and no interest paid by the issuer. Different to their paper, lenders in my model have to worry that their coins may be devalued by the time they are returned. Thus, the borrower must compensate for a higher probability of runs with a higher interest rate.

The three stages of the modified game with stablecoin lending are discussed in more detail in Appendix A.6 and summarized in Table A3. The derivations are relegated to Appendix A.7, where I also present the modified parameter assumptions. Proposition 9 summarizes formally.

**Proposition 9.** ***(Stablecoin lending and speculation)*** *Given Assumption 2 and* $\sigma \searrow 0$*, the size of the borrower is positively (negatively) associated with the flightiness of coin holders in state* $z = 1$ *(*$z = 2$*),* $\lim_{q \to 0} d\theta_1^*/d\delta > 0$ *and* $\lim_{q \to 0} d\theta_2^*/d\delta < 0$*, provided the sensitivity of the induced payment preference, i.e.* $d\overline{\gamma}/dN$*, is not too strong. Additionally, the size of the borrower is either negatively associated with the lending rate,* $\lim_{q \to 0} dr_\ell^*/d\delta < 0$*, or positively associated with the adoption rate,* $\lim_{q \to 0} dN^*/d\delta > 0$*, or both. Conversely, the probability that the borrower is a speculator is either positively associated with the lending rate,* $dr_\ell^*/q > 0$*, or negatively associated with the adoption rate,* $dN^*/dq < 0$*, or both.*

**Proof.** See Appendix Section A.5.7.

Taken together, the results in Proposition 9 indicate that the introduction of stablecoin lending tends to promote stability and adoption if the benefits are not eroded by speculation. This is because stablecoin lending can allow coin holders to earn a better expected return on their coins, thereby making adoption more attractive, similar to the effect of an increase in $\alpha$ due to an adoption externality (see Section 5.1). Notably the borrower's size has a differential effect on the flightiness of coin holders in states $z = 1$ and $z = 2$. Intuitively, the stabilizing effect in state $z = 2$ prevails from an ex-ante perspective as long as there is only a small probability of the state $z = 1$ when the borrower is a speculator. An increasing threat of facing a speculator erodes the stabilizing effect, which is reflected not only in a potential reduction in the adoption rate, but also in the need to offer a higher interest rate $r_\ell$ to compensate lenders. Since lenders have to worry about the possibility that their coins will be devalued by the time they are returned, stablecoin lending has both benefits and costs. From the viewpoint of regulators, lending rates are informative about the risk of runs, with higher lending rates indicating higher fragility (see also Prediction 4 in Section 6).

### 5.3 Congestion: Endogenous Conversion Cost

Due to the importance of congestion effects in crypto market, the stabilizing role of transaction costs appears to be a relevant feature of crypto asset markets, where a large volume of transactions in a short time window can trigger substantial increases in transaction fees. I document such an event in Figure A1 in the Appendix for the period around the devaluation of USD Terra in May 2022, when the transaction fees for on-chain transactions on the Ethereum network (which was the dominant network used by USD Terra) shot up more than four-fold, which may have helped to reduce outflows from Tether, counteracting contagion effects across stablecoins. To study the role of an endogenous response of conversion costs to congestion, I assume in this extension that the conversion cost at time 1 given by $\tau_1^e(A) = \overline{\tau} + \omega A$ with $\omega > 0$. Similar to Diamond-Dybvig models with increasing nominal time 1 good prices (Skeie 2021; Schilling et al. 2021), an increase of the conversion cost due to a higher aggregate conversion demand rations the conversion run threat.

Corollary 4 shows formally that a stronger endogenous response to congestion has a stabilizing effect. Perhaps surprisingly, the probability of runs is lower than in the benchmark model even if the endogenous conversion cost is lower than the exogenous conversion cost used in the benchmark model for a wide range of aggregate conversion demands, which can reach up to $A = 1/2$.

**Corollary 4.** ***(Endogenous congestion cost)*** *Under the conditions of Proposition 2, the revised equilibrium condition for the stablecoin runs game is:*

$$I^e(\theta^*;\overline{\gamma}) \quad \equiv \quad [\beta - \alpha - 2\overline{\gamma}]\tau_2 - \left(\overline{\tau} + \frac{\omega}{2}\right) + \int_{\frac{(\theta^*-1)r}{\kappa(\theta^*-r)}}^{1} \left(1 - \frac{\frac{r-\kappa A}{r}\theta^* - \psi}{1-\kappa A}\right) dA = 0. \tag{20}$$

*The probability of runs decreases when the conversion cost is more sensitive to increases in the conversion demand, i.e. $d\theta^*/d\omega < 0$. Moreover, the probability of runs is lower than in the benchmark model with an exogenous conversion cost if $\tau_1 < \overline{\tau} + \omega/2$. This result holds even if $\tau_1^e(A) < \tau_1, \forall A \in [0, 1/2)$.*

### 5.4 Resilience of the Issuer

The probability of stablecoin runs, $Prob\{\theta \leq \theta^*\}$, stands in a close relationship to the profitability and resilience of the issuer via the critical threshold $\hat{A}(\theta)$ from Equation (4), which describes the strength of the issuer to stem against conversion demands at time 1. I consider two modifications of the baseline model that are are relevant for the stablecoins market and alter the issuer profits in Equation (17). First, a variant of the model with fixed costs of operation, and second, a variant where the issuer can generate income from transaction fees.

So far, I assumed that the issuer does not face costs of operation. Now, consider a fixed operating cost $\xi > 0$ that accrues at time 0 and that is deducted from the funds collected:[23]

$$\pi(\theta^*, N^*; \xi) = \int_{\theta^*(N^*;\xi)}^{\overline{\theta}} \frac{(N^*(\xi) - \xi)\theta - N^*(\xi)}{\overline{\theta} - \underline{\theta}} \, d\theta. \tag{21}$$

Observe that $\xi$ lowers the issuer's profits for a given $\theta^*$ and $N^*$. Furthermore, profits decrease in $\theta^*$ and increase in $N^*$. I show in the Proof of Proposition 10(a) that $d\theta^*/d\xi > 0$ and $dN^*/d\xi < 0$, meaning that the reduction in profits gives rise to a destabilizing effect and to a lower adoption. This is because of a lower resilience of the issuer who is insolvent already for a lower level of aggregate conversion demand. The fixed cost lowers the available resources, thereby making it harder to meet the payment obligations:

$$\hat{A}(N^*; \theta, \xi) \equiv \frac{\frac{N^* - \xi}{N^*}\theta - 1}{\kappa(\theta - r)} r < \hat{A}(\theta), \forall \xi > 0. \tag{22}$$

Notably, for a given average level of $\overline{\gamma}$, the described effect is weakened as adoption increases, since the fixed cost is shared by a larger user base (formally, $\xi$ is divided by $N^*$).

Next, I consider the variant of the model with transaction fee income. In practice, part or all of the transaction cost may stem from fees earned by other parties, such as by crypto miners for on-chain transactions or by cryptocurrency exchanges and other intermediaries for off-chain transactions. However, some stablecoins are affiliated with exchanges (e.g. USD Coin with Coinbase and Binance Coin with Binance), meaning that issuers may accrue part of the fees. To account for this institutional feature, I consider a profit sharing arrangement between the issuer and other parties. Let $f \in [0, 1]$ denotes the fraction of transaction costs that are accounted for as fee income by the issuer. The modified issuer profits are:

$$\pi(\theta^*, N^*; f) = \int_{\theta^*(N^*;f)}^{\overline{\theta}} N^* \frac{\theta - 1 + (\beta - \overline{\gamma}) f \tau_2}{\overline{\theta} - \underline{\theta}} \, d\theta, \tag{23}$$

where $\beta - \overline{\gamma}$ is the weighted average over the group-specific probabilities to meet a consumption good seller who only accepts bank deposit, meaning that coin holders need to convert to bank deposits at time 2 and incur the transaction cost $\tau_2$. Now, the issuer is only insolvent for a higher aggregate conversion demand:

$$\hat{A}(\theta, f) \equiv \frac{\theta - 1}{(1 - f\tau_1)\theta - r} \frac{r}{\kappa} > \hat{A}(\theta), \forall f > 0. \tag{24}$$

The additional resources available translate into a higher critical threshold for the population fraction of coin holders demanding conversion, i.e. $d\hat{A}(\theta, f)/df > 0$ provided $f\tau_2$ is not too large. The extra revenue promotes the issuer's ability to meet its payment obligations. Proposition 10(b) shows that this results in a lower probability of stablecoin runs and the intuition is similar before.

[23]A variable cost has effects that are identical to a reduction in transaction fee income, which is discussed in below.

**Proposition 10.** ***(Fixed costs of operation and transaction fee income)*** *Under the conditions of Proposition 2, the probability of a stablecoin run:*

*(a) increases in the level of the fixed cost:* $d\theta^*/d\xi > 0$

*(b) decreases in the fraction of transaction fee income:* $d\theta^*/df < 0$*, provided* $(f \cdot \tau_2)$ *is not too large.*

**Proof.** See Appendix Section A.5.8.

### 5.5 Stablecoins vs. E-money, Narrow Banking, and Hybrid CBDC

The US appears to move towards a regulation that only allows federally insured banks and non-bank financial institutions subject to a 100% reserve requirement to issue stablecoins. Indeed, tightly regulated stablecoins issued by insured depository institutions and by narrow banks may be a substitute for a US retail CBDC (Waller 2021; Andolfatto 2021b). If implemented and accompanied by adequate safeguards for operational and technological risks, as well as a backstop by the Federal Reserve, such a policy would make regulated stablecoins risk-less and suitable as a medium of exchange that fulfills the *no-questions-asked* principle put forward by Gorton and Zhang (2021). This approach is also compatible with a hybrid CBDC architecture that allows users to have a direct claim on the central bank (BIS 2021). The Chinese e-CNY has a hybrid CBDC architecture. At the same time, China took a more traditional narrow banking approach with payment platforms Alipay and WeChat Pay after the People's Bank of China decided in 2019 that all funds backing their e-monies must be invested in deposits at state-owned commercial banks.

Also in Europe and in other parts of the world policy markers are determined to step up the regulation of stablecoins, as to limit exposures to liquidity risk, return risk and operational risks. The European Markets in Crypto-Assets (MiCA) regulation proposal classifies stablecoins that are pegged to a fiat currency as "e-money tokens" (EC 2020). After the implementation of MiCA (scheduled for 2024), the provision of crypto-asset services in the European Union (EU) requires companies to obtain a license and to adhere to requirements regarding their capitalization, governance, asset separation, safekeeping of funds and more.

Through the lens of the model, tightly regulated stablecoin issuers can be captured by changing the return profile of the fundamental $\theta$ and the cost from divesting assets. Requiring stablecoin issuers to invest only in the safest assets (e.g., short-term Treasuries) and introducing capital requirements to withstand potential losses from operational or cyber risk can ensure that $\underline{\theta} \geq 1$. Thereby, regulators can rule out states of the world where the value of stablecoins falls below \$1 even if there are no redemption requests at time 1. What remains are liquidity concerns arising from high redemption volumes at time 1 if there is a cost from divesting assets, which can lead to panic based runs. In my model this can be captured by assuming that there is incomplete information about $r$. More formally, let $r'(\theta) > 0$ and $0 < r(\theta) \leq 1, \forall \theta \in [\underline{\theta}, \overline{\theta}]$. Applying the same global games methodology, it can be shown that main insights from Section 3.1 go through.

How can a policy maker rule out fragility due to panic runs that are purely based on liquidity concerns? One option is to give stablecoin issuers access to the central bank balance sheet. Central bank liquidity assistance can ensure that $r \geq 1$ holds in all states of the world, even in case of large redemption volumes at time 1. Another option is to require issuers to hold central bank reserves and to operate like a narrow bank. A remaining concern is the low profitability of stablecoin issuers in an low interest rate environment, which may require an additional capital buffer or subsidies to ensure the solvency and viability of issuers.

### 5.6 Alternative Model Specifications and Robustness

Throughout the paper, I assume that a devaluation of stablecoins does not affect their use as a means of payment, i.e. $\alpha_g$ and $\beta_g$ are not affected by a devaluation. This simplification is critical, as it allows to average over the group-specific $\gamma_g$s by applying the Belief Constraint of Sákovics and Steiner (2012), because the $\gamma_g$s are not contingent on the aggregate action. In the model section I argue that this assumption is plausible. It can be shown that the robustness of the key insights when considering an alternative specification where the seller's preference for payment in stablecoins is lower in case of a devaluation at time 1, which requires to restrict attention to the analytically tractable case with two coin holder types.

Another important assumption is that the stablecoin issuer is a monopolist. The existence of multiple issuers highlights the relevance of the previous discussion on fixed costs of operation in Section 5.4, which are with multiple issuers duplicated and spread across smaller user bases. Therefore, the smallest issuers may be the most vulnerable. Instead, the destabilizing composition effect described in Section 3.1 gains in importance if the issuer with the highest adoption disproportionately attracts flighty coin holders, which could make the dominant issuer more vulnerable.

From a regulatory perspective, it is of particular importance to focus on the weakest link if the risk of contagion is high. The emerging empirical literature on crypto assets documents a high degree of interconnectedness in the crypto universe. Market spillovers dwarf the variation caused by idiosyncratic characteristics (Ferroni 2022). This is also true for the stablecoins universe, which displays a high co-movement between different stablecoins and with other crypto assets (Gorton, Ross and Ross 2022a). Therefore, it is insufficient to focus on the fragility of one issuer in isolation. Moreover, institutional similarities and the interconnectedness are likely to imply that a run against the most fragile stablecoin constitutes a wake-up call for coin holders, which makes them more likely to demand conversion also for other coins (Ahnert and Bertsch 2022).

## 6 Testable Implications

The nascent empirical literature on the stablecoins market has documented that stablecoins play a key role in the 1-2tn market for crypto assets denominated in US dollars (Hoang and Baur 2021). Moreover, there is an increasingly closer link with traditional financial markets, as well as a high co-movement within the stablecoins universe, which raises the risk of contagious runs

(Gorton et al. 2022a).[24] Due to the large holdings of stablecoin issuers, changes in the stablecoin market capitalization affect the US commercial paper and treasury markets (Barthelemy, Gardin and Nguyen 2021; Kim 2022). As the stablecoin market continues to evolve, further research in this area will be critical to ensuring stability and resilience through the design of effective regulatory frameworks.

This section discusses implications offered by the theory developed in this paper and how they could be tested. First, the model offers a prediction for stablecoin adoption and fragility that emphasizes the destabilizing role of increasingly flighty stablecoin adopters (Corollary 1).

**Prediction 1:** *The most marginal (or recent) adopters are more flighty than the average coin holder.*

Prediction 1 rests on a key model assumption about the demand schedule for stablecoins. Does the marginal stablecoin adopter become more flighty when adoption reaches broader market segments? By how much? One way to test the validity of the assumption is to group addresses according to whether they belong to early stablecoin adopters or to more recent adopters. Thereafter, the groups can be associated with a flightiness measure based on the sensitivity to deviations from the peg. Provided the most recent adopters are the most flighty and, therefore, can be classified as the marginal coin holders, Prediction 1 follows.

Next, the model offers predictions for stablecoin adoption and fragility in relation to the role of stablecoins as a means of payment (Section 3.1) and network effects (Section 5.1).

**Prediction 2a:** *(1) The value of stablecoins as a means of payment and (2) the intensity of network effects are positively associated with the stability of stablecoins.*

**Prediction 2b:** *For a given level of adoption, an increase in (1) the value of stablecoins as a means of payment and/or in (2) the intensity of network effects reduces the flightiness of the marginal coin holder.*

Predictions 2a and 2b are based on Proposition 2 and Corollary 3. They could be tested with the help of empirical measures to gauge the strength of network effects in the stablecoins market, including measures for platform user retention (possibly by user cohort, e.g. early adopters vs. late adopters), for market depth, for the concentration of supply and demand, and for the cost of switching between different coins. The value of stablecoins as a means of payment, which is a proxy for the medium of exchange function of stablecoins, can be assessed by measuring the scope to use them to purchase goods and services, and by measuring the transaction fees for purchasing crypto assets. Regarding the fragility of the stablecoin issuer, a stability measure can be constructed based on the narrowness of the bands around the peg to the U.S. dollar and the frequency of violations of the peg, potentially taking advantage of cross-sectional variation.

Next, I turn to conditions under which stablecoins may be prone to runs that have to do with the characteristics of traders and the market infrastructure.

[24] Gorton et al. (2022a) measure the frictions faced by stablecoin holders when transacting and converting their coins to fiat currency, documenting a negative association with the convenience yield and a high co-movement. Grobys, Junttila, Kolari and Sapkota (2021) show that Bitcoin volatility is an important factor driving the volatility of stablecoins. In related work, Lyons and Viswanath-Natraj (2020) show that Tether's peg to the US dollar is primarily stabilized by arbitrage traders, rather than by the issuer.

**Prediction 3:** *The stability of stablecoins increases if the proportion of active traders is lower.*

**Prediction 4:** *ThesStability of stablecoins increases if transaction costs are more sensitive to spikes in conversion demand.*

Prediction 3 is based on the negative effect of the proportion of active traders, $\kappa$, on the stability of the stablecoin issuer (Proposition 2). Testing this prediction requires to identify the traders who are most sensitive to deviations from the peg, for instance by examining how many addresses can be detected as "active" during periods when there are significant deviations from the peg. Prediction 4 follows from Corollary 4 on the role of congestion effects. It can be tested using data on transaction fees and volumes on the Ethereum network. Regular network updates and changes in the market infrastructure may offer quasi-exogenous shocks to the sensitivity of conversion costs to congestion effects in the market for stablecoins.

Finally, Prediction 5 turns to the role of the stablecoins market.

**Prediction 5:** *For a given level of adoption, the stablecoin lending rate decreases in the share of non-speculative use.*

The prediction is based on the finding that $dr_{\ell}^{*}/d(1-q) < 0$ for a given level of adoption. Moreover, Proposition 9 also suggests a negative association between the size of the stablecoin lending market and the stablecoin lending rate, which is driven by an increase in stability. To test the prediction, the share of speculative activity in the stablecoins lending market could be gauged with the help of speculative DeFi positions, especially by DeFi liquidators. Notably, Prediction 5 relies on the risk of a devaluation by the time the coins are returned to lenders, and is shared with d'Avernas et al. (2022), who also have a positive relationship between the lending rate and fragility.

# 7 Discussion

Stablecoins have received considerable attention from policymakers following the Facebook Libra stablecoin announcement in June 2019, and in light of the rapid expansion of the crypto universe. Importantly, stablecoins serve as a critical link to traditional financial markets, as documented in recent empirical work. Because the stablecoin market is prone to instability, it may pose broader financial stability risks going forward (FSB 2022). Therefore, it is important to understand the determinants of stablecoin adoption and fragility, and to think about the appropriate regulation. The theoretical framework developed in this paper aims to inform the risk assessment of the market for stablecoins and the ongoing policy debate on how to regulate stablecoins.

The approach taken in this paper is to modify existing theories to study bank runs and currency attacks by incorporating important features of the stablecoin market. Crucially, I introduce payment preferences that generate a demand for stablecoins and analyze how stablecoin adoption interacts with the fragility of the stablecoin issuer. Different from a typical Diamond and Dybvig-type model, where the bank chooses assets to trade off returns, liquidity provision, and run risk, the stablecoin adoption game endogenizes the liability side. When deciding whether or not to adopt stablecoins, consumers trade off the benefits of stablecoins with the return differential relative to insured bank deposits and the risk of devaluation.

I find that stablecoin adoption is likely to be excessive, because the marginal adopter does not internalize that a wider adoption of stablecoins is associated with a destabilizing composition effect ("Tether scenario"). Moreover, she does also not internalize the potential erosion of the value of bank deposits as a means of payment ("Facebook Libra scenario"). This results speak to regulatory concerns about a rapid and widespread adoption of stablecoins that is socially undesirable. Regarding the determinants of fragility, I document that factors that increase the issuer's revenue from fees and seigniorage promote stability, as do congestion effects that are associated with an increase in transaction costs during times of stress. In addition, I find that a regulatory disclosure framework that promotes transparency can reduce risk-taking by stablecoin issuers. However, only a heavy-handed regulation with capital requirements can guarantee the socially efficient level of risk-taking. Finally, I find that the recent phenomenon of stablecoin lending can promote both stability and adoption if it does not invite speculation.

Forthcoming regulation on both sides of the Atlantic, flanked by an effort to coordinate policies internationally,[25] holds the promise to mitigate certain risks. While multiple G7 statements noted that "no global stablecoin project should begin operation until it adequately addresses relevant legal, regulatory, and oversight requirements through appropriate design and by adhering to applicable standards",[26] the actual regulation remains challenging in light of the global nature of crypto asset markets[27] and the speed of innovation, especially in decentralized finance.[28] Thus, it is plausible to envision a future with a bifurcated market consisting of regulated and unregulated stablecoins. In fact, the introduction of a CBDC can be seen as an insurance policy and its development was motivated by the rapid growth of stablecoins (Arner, Auer and Frost 2020; Landau and Brunnermeier 2022; FSR 2022).

[25]This effort is lead by the Basel Committee on Banking Supervision and the Committee on Payments and Market Infrastructures. See, e.g., BIS (2022) and CPMI-IOSCO (2020).

[26]Almost identical language was used in subsequent G7 statements in 2019, 2020 and 2021: `https://www.gouvernement.fr/en/chair-s-statement-on-stablecoins` and `https://home.treasury.gov/news/press-releases/sm1152`.

[27]The leading stablecoin Tether is domiciled in the British Virgin Islands and it's partner bank Deltec Bank & Trust is domiciled in the Bahamas. Similarly, many cryptocurrency exchanges are domiciled in off-shore locations with opaque ownership structures.

[28]The natural starting point for financial regulators are intermediaries such as cryptocurrency exchanges and wallet providers. Therefore, the emergence of decentralized autonomous organizations (DAOs) based on smart contracts further complicates effective regulation, as DAOs not only obscure traditional notions of ownership, but they also rely less on intermediaries.

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# A Appendix

## A.1 Additional Figures and Tables

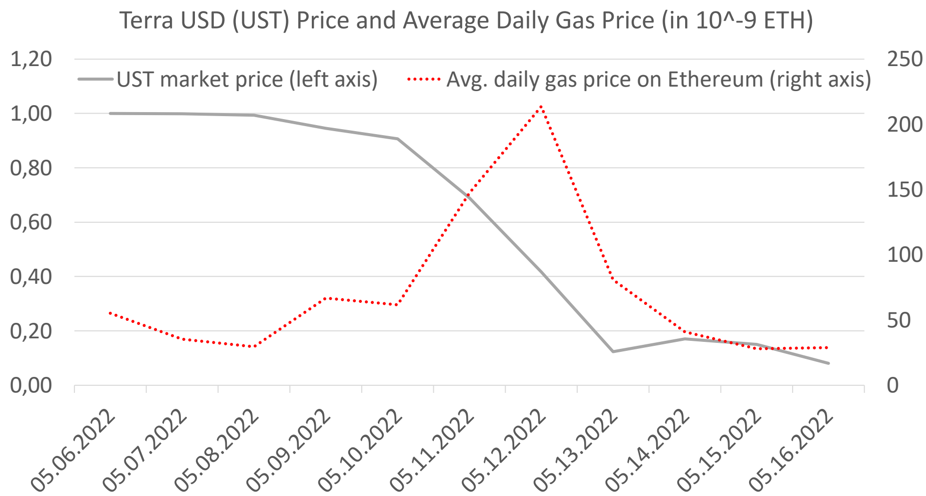


Figure A1: End of day (CEST) price in US dollars (left axis) and average daily gas price on the Ethereum network measured in $10^{-9}$ units of the cryptocurrency *ETH* (right axis) over the period from May 6, 2022 to May 16, 2022. Source: coingecko.com and ycharts.com.

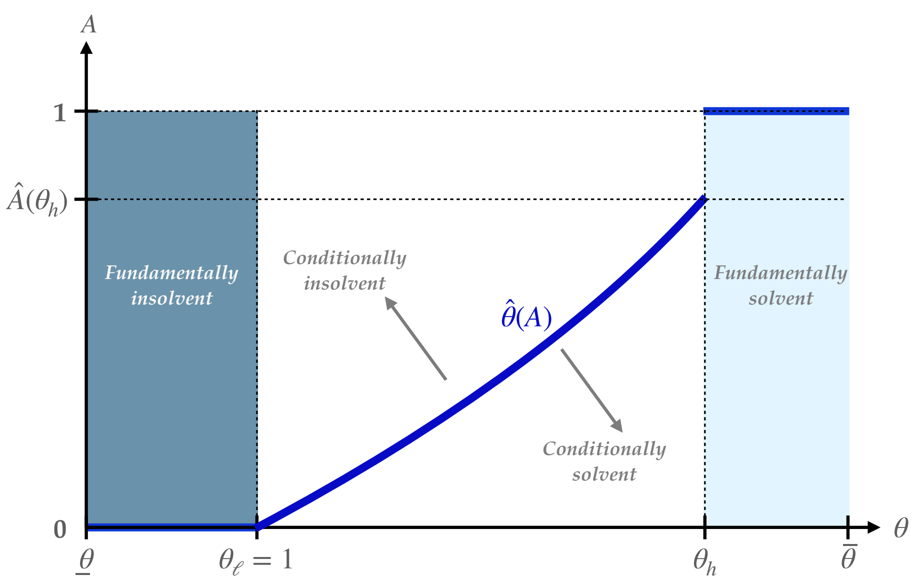


Figure A2: Solvency of the stablecoin issuer as a function of the fundamental realization $\theta$ and the population fraction $A$ of coin holders demanding conversion. Only in the intermediate region, $\theta \in (\theta_\ell, \theta_h)$, the solvency of the issuer depends on the level of the aggregate conversion demand $A$.

| Time 0 | Time 1 | Time 2 |
|---|---|---|
| 1. **Adoption game:** Consumers simultaneously decide whether to convert their bank deposits to stablecoins, $a_{0,i} = 1$, or not, $a_{0,i} = 0$<br>2. The stablecoin issuer invests all funds received from consumers who adopt stablecoins | 3. The fundamental $\theta$ is realized but unobserved and a fraction $\kappa$ of coin holders become active<br>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<br>5. The stablecoin issuer meets coin holders' conversion requests by divesting assets | 6. The outcome of the time 1 stablecoin conversion game and the fundamental realization $\theta$ are observed; the preference of each consumer is realized<br>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<br>8. Consumers buy goods from their preferred seller and convert their money (if necessary)<br>9. Sellers A and C convert the stablecoins earned; all sellers pay production costs with government-backed deposits (or dollars) |

Table A1: Timeline of events.

## A.2 Tether Asset Breakdown

Table A2 shows Tether's self-reported asset breakdown as of June 2022 and September 2022, when USDT was backed by a range of risky assets, including corporate bonds, secured loans, investments in digital tokens, commercial paper and deposits in non-US regulated financial institutions. The latest reporting from June 2023 in column 3 indicates a reduced exposure to commercial paper and bank deposits, but more granular data is not available, and the quarterly reporting is published with a substantial delay.

## A.3 Complete Information Benchmark: $\sigma = 0$

This Appendix section considers the benchmark with complete information where active coin holders obtain a precise signal at $t = 1$, i.e. $\sigma = 0$, about the resources available to the stablecoin issuer at time 2.

Suppose that an individual active coin holder $i$ believes that others keep their coins, i.e. $a_{1,-i} = 0$. Then her optimal strategy is to demand conversion if and only if the differential payoff from conversion relative to keeping the coins is weakly positive. Weak preference for demanding conversion holds if $\theta \leq \theta_\ell = 1$, which gives us a lower bound for $\theta$ such that it is the (weakly) dominant action to demand conversion for all $\theta \leq 1$.

Following the same logic, I can derive the upper bound from the weak preference for not

| **Assets** | | **Value in bn USD** | | |
|---|---|---|---|---|
| | | 06/30/2022 | 09/30/2022 | 06/30/2023 |
| Commercial Paper | | 8,402 | 50 | |
| & Certificates of Deposit | A-1+ rating | 1,434 | 50 | |
| | A-1 rating | 5,465 | | |
| | A-2 rating | 1,499 | | |
| Cash & Bank Deposits | | 5,418 | 6,077 | 91 |
| Money Market Funds | | 6,810 | 7,102 | 8,134 |
| U.S. Treasury Bills | | 28,856 | 39,678 | 55,810 |
| Non-U.S. Treasury Bills | | 397 | 182 | 63 |
| Reverse Repurchase Agreements | | 2,992 | 3,024 | 9,470 |
| Secured Loans | | 4,494 | 6,136 | 5,504 |
| Corporate Bonds, Funds & Precious Metals | | 3,487 | 3,194 | 3,386 |
| Other Investments & digital tokens | | 5,551 | 2,617 | 4,041 |
| Total | | 66,410 | 68,061 | 86,499 |

Table A2: Tether asset breakdown at 30 June 2022, 30 September 2022 and 30 June 2023. Assurance opinion by *BDO*, Italy.

demanding conversion if the active coin holder *i* believes that all others demand conversion, i.e. if $a_{1,-i} = 1$. Given:

$$\gamma_s \geq \hat{\gamma} \equiv \frac{(\beta - \alpha)\tau_2 - \tau_1}{2\tau_2}, \tag{25}$$

it is the (weakly) dominant action for all coin holders to keep their stablecoins if $\theta \geq \theta_h$, where $s \in \{1, ..., G\}$ denotes the group of coin holders with the lowest probability of being matched with a seller who has a preference for stablecoin payments. As the analysis of the conversion game at time 1 requires that stablecoins are adopted at least by some consumers, I now assume (and later show) that Inequality (25) holds, which intuitively requires that the preference for bank deposits as a means of payment $\beta - \gamma_G$ cannot be too high.

Next, I analyze what happens in the intermediate region $\theta \in [1, \theta_h]$. Recall that the intermediate region is non-empty and observe that for any $\theta \in [1, \theta_h]$, multiple belief-driven equilibria exist. Specifically, there always exists a pure strategy Nash equilibrium where all coin holders demand conversion and a pure strategy Nash equilibrium where all coin holders keep their stablecoins. Proposition 11 summarizes.

**Proposition 11.** ***(Continuation equilibrium under complete information)*** *Let $\sigma = 0$. Given Assumption 1 and a positive level of adoption $N > 0$, there exists a unique equilibrium of the conversion game where all active stablecoin holders demand conversion if $\theta \in [\underline{\theta}, 1)$ and a unique equilibrium where no stablecoin holder demands conversion if $\theta \in (\theta_h, \overline{\theta}]$. In the intermediate range, $\theta \in [1, \theta_h]$, there exist multiple pure strategy Nash equilibria.*

### A.4 Derivation of Dominance Regions

Let $\gamma_s \geq \hat{\gamma}$, where $\hat{\gamma}$ is defined in Equation (25). I characterize the upper and lower dominance regions.

**Upper dominance region.** A coin holder belonging to group $g \in \{s,...,G\}$ with the signal $x_i > \overline{x}_g$ strictly prefers to keep her coins even when all other active coin holders demand conversion, i.e. $A = 1$, where $\overline{x}_g$:

$$Prob\{\theta \geq \theta_h | x_i = \overline{x}_g\} - 1 + \Psi_g \tau_2 + \tau_1 + \int_{\underline{\theta}}^{\theta_h} \frac{\frac{r-\kappa}{r}\theta - \psi}{1-\kappa} h(\theta | x_i = \overline{x}_g) d\theta = 0. \tag{26}$$

Observe that the left-hand side of Equation (26) takes on a negative value if $x_i < \theta_h - \sigma\varepsilon$ and a positive value if $x_i > \theta_h + \sigma\varepsilon$ and $\tau_1 + \Psi_g \tau_2 > 0$, which holds provided there is adoption of stablecoins. Moreover, the left-hand side strictly increases in $x_i = \overline{x}_g$. As a result, a sufficient condition for no conversion demand by all coin holders can be obtained by solving Equation (26) for the marginal group $s$. There exists a unique $\overline{x} \equiv \overline{x}_s$ such that it is the dominant action for all coin holders with a private signal $x_i > \overline{x}$ to keep their coins.

**Lower dominance region.** Analogously, a coin holder belonging to group $g \in \{s,...,G\}$ who receives the private signal $x_i < \underline{x}_g$ strictly prefers to demand conversion even when all other coin holders keep their stablecoins, i.e. $A = 0$, where $\underline{x}_g$ solves:

$$\begin{aligned} & Prob\{\theta \leq \theta_\ell | x_i = \underline{x}_g\}(1 - \tau_1 - \alpha_g \tau_2) - \int_{\underline{\theta}}^{1} \left( \frac{\frac{r-\kappa}{r}\theta - \psi}{1-\kappa} - \beta_g \tau_2 \right) h(\theta | x_i = \underline{x}_g) d\theta \\ - \quad & Prob\{\theta > \theta_\ell | x_i = \underline{x}_g\}(\tau_1 + \Phi_g \tau_2) = 0. \end{aligned} \tag{27}$$

Observe that the left-hand side of Equation (27) takes on a positive value if $x_i < \theta_\ell - \sigma\varepsilon$ due to $\psi > \overline{\psi}$ in Assumption 1. Conversely, it takes on a negative value if $x_i > \theta_\ell + \sigma\varepsilon$ since $-\tau_1 - \Phi_g \tau_2 < 0$. Moreover, the left-hand side is strictly decreasing in $x_i = \underline{x}_g$. As a result, a sufficient condition for no conversion demand by all coin holders can be obtained by solving Equation (27) for group $G$. There exists a unique $\underline{x} \equiv \underline{x}_G$ such that it is the dominant action for all coin holders with a private signal $x_i < \underline{x}$ to demand conversion.

### A.5 Proofs

#### A.5.1 Proof of Proposition 1

I start with preliminary results. Following Sákovics and Steiner (2012) I rescale the aggregate action as:

$$\tilde{A}(\xi, \Gamma) \quad \equiv \quad \Sigma_{g=s+1}^{G} m_g F(\Gamma_g - \xi) + m_s \mu_s F(\Gamma_s - \xi),$$

where $\xi$ is a scalar and $\Gamma$ is a vector of $\Gamma_g$s that relates the group-specific threshold signals to the signal threshold of a group $k$ as follows: $\Gamma_g \equiv (x_g^* - x_k^*)/\sigma$ and $\theta = x_k^* + \sigma\xi$. Then I write the strategic beliefs as:

$$A_g(A,\Gamma) = \Pr\{\tilde{A}(\Gamma_g - \varepsilon, \Gamma) < A\} = \Pr\{\Sigma_{h=s+1}^G m_h F(\Gamma_h - \Gamma_g + \varepsilon) + m_s \mu_s F(\Gamma_s - \Gamma_g + \varepsilon) < A\}.$$

Define $\vartheta(A,\Gamma)$ as the inverse function of $\tilde{A}(\xi,\Gamma)$ with respect to $\xi$, where $d\vartheta/dA < 0$, because $d\tilde{A}(\xi,\Gamma)/d\xi < 0$ for $\tilde{A}(\xi,\Gamma) \in (0,1)$. Next, following Lemma 4 in Sákovics and Steiner (2012) I establish that the densities associated with the strategic belief are bounded:

$$0 \leq \frac{\partial A_g(A,\Gamma)}{\partial A} = \frac{f(\Gamma_g - \vartheta(A,\Gamma))}{\Sigma_{g=s+1}^G m_g f(\Gamma_g - \xi) + m_s \mu_s f(\Gamma_s - \xi)} \leq \frac{1}{m_g}.$$

Finally, I define the expected utility payoff of the threshold type as:

$$H_g^\sigma(x_1,\Gamma) \quad \equiv \quad E[\Delta(A;\theta,N)|(x_g^*, g_i = g)] = \int_0^1 \Delta(x_1 + \sigma\vartheta(A,\Gamma), A) dA_g(A,\Gamma),$$

where I drop the adoption rate in the last line for simplicity.

Note that the beliefs are independent of $\sigma$ so that the $H_g^\sigma(x_k,\Gamma)$'s are well-defined for all $\sigma \geq 0$.

The proof proceeds in three steps. In *Step 1* I follow the translation argument in Frankel et al. (2003) and establish by contradiction that if there is a solution to the system of indifference conditions given by:

$$H_g^\sigma(x_1,\Gamma) = 0, \forall g \in \{s,...,G\},$$

then it must be unique. Thereafter, I establish equilibrium convergence in *Step 2* and apply in *Step 3* the Belief Constraint of Sákovics and Steiner (2012) to derive Equation (12) in Proposition 1. Finally, existence can be established by iterated elimination of dominated strategies.

*Step 1:* Suppose there exist two distinct solutions, $(x_1,\Gamma)$ and $(x_1',\Gamma')$.

First, consider the case where $\Gamma = \Gamma'$ and $x_1 \neq x_1'$. Recall that $\Delta_i$ is weakly decreasing in $\theta$ for all groups so that $\Delta_i(x_1' + \sigma\vartheta(A,\Gamma'), a) \leq \Delta_i(x_1 + \sigma\vartheta(A,\Gamma), a)$ if $x_1' > x_1$. Moreover, $A^* > (A^*)'$ if $x_1' > x_1$ since $\hat{A}(\theta)$ is strictly increasing in $\theta$. As a result, $A_g(A^*,\Gamma) > A_g((A^*)',\Gamma)$. There is a contradiction: $H_g^\sigma(x_1',\Gamma) < H_g^\sigma(x_1,\Gamma)$, because $\Delta_i(x_1' + \sigma\vartheta(A,\Gamma')) \leq \Delta_i(x_1 + \sigma\vartheta(A,\Gamma))$ for $A \in ((A^*)', A^*)$ due to the discontinuity of $\Delta_i$ at the solvency threshold $\hat{A}(\theta)$ so that:

$$\int_0^1 \Delta_i(A, x_1' + \sigma\vartheta(A,\Gamma)) dA_g((A^*)',\Gamma) < \int_0^1 \Delta_i(A, x_1 + \sigma\vartheta(A,\Gamma)) dA_g(A^*,\Gamma).$$

Second, consider the case where $\Gamma \neq \Gamma'$ and, without loss of generality, $x_1 \leq x_1'$. Choose $h \in \arg\max_g(\Gamma_g' - \Gamma_g)$ and let $D = \max_g(\Gamma_g' - \Gamma_g) \geq 0$. Notice that $\Gamma_h' - \Gamma_g' \geq \Gamma_h - \Gamma_g, \forall g \in \{s,...,G\}$ holds with strict inequality at least for one group $g$ due to the assumption that $\Gamma \neq \Gamma'$. Let $\tilde{x}_1 = x_1' + \sigma D$, then:

$$H_h^\sigma(\tilde{x}_1,\Gamma) \leq H_h^\sigma(x_1,\Gamma),$$

which, as I will show below, leads to a contradiction. Next, use the substitution $a = \tilde{a}(\Gamma_h - \varepsilon_h, \Gamma)$, $\tilde{x}_h = \tilde{x}_1 + \sigma\Gamma_h$, and $x'_h = x'_1 + \sigma\Gamma'_h$ to re-write the expected utility payoff as:

$$H_h^\sigma(\tilde{x}_1,\Gamma) = \int_{-\varepsilon}^{+\varepsilon} \Delta_h(\tilde{x}_h - \sigma\varepsilon_h, \tilde{a}(\Gamma_h - \varepsilon_h,\Gamma))df(\varepsilon_h)d\varepsilon_h$$
$$H_h^\sigma(x'_1,\Gamma') = \int_{-\varepsilon}^{+\varepsilon} \Delta_h(x'_h - \sigma\varepsilon_h, \tilde{a}(\Gamma'_h - \varepsilon_h,\Gamma'))df(\varepsilon_h)d\varepsilon_h,$$

where I used that $\vartheta(A,\Gamma)$ is the inverse function of $\tilde{A}(\xi,\Gamma)$ with respect to $\xi$. Observe that $\tilde{x}_h = x'_1 + \sigma D + \sigma\Gamma_h = x'_h$. Moreover, because of $\Gamma'_h - \Gamma'_g \geq \Gamma_h - \Gamma_g, \forall g \in \{s,...,G\}$:

$$\Sigma_g m_g(1 - F(\Gamma'_g - \Gamma'_h + \varepsilon_h)) + m_s\mu_s(1 - F(\Gamma_s - \Gamma'_h + \varepsilon'_h)) \geq \Sigma_g m_g(1 - F(\Gamma_g - \Gamma_h + \varepsilon_h)) + m_s\mu_s(1 - F(\Gamma_s - \Gamma_h + \varepsilon_h)),$$

which implies: $\tilde{a}(\Gamma'_h - \varepsilon_h, \Gamma') \geq \tilde{a}(\Gamma_h - \varepsilon_h, \Gamma), \forall \varepsilon_h$. Next, I establish strict inequality by noting that the $\varepsilon_h^*$ solving $\tilde{a}(\Gamma_h - \varepsilon_h^*, \Gamma) = \hat{A}(\tilde{x}_h - \sigma(\varepsilon_h^*))$ and the $(\varepsilon_h^*)'$ solving $\tilde{a}(\Gamma'_h - (\varepsilon_h^*)', \Gamma') = \hat{A}(x'_h - \sigma(\varepsilon_h^*)')$ are related to each other as $(\varepsilon_h^*)' \geq \varepsilon_h^*$ for $\tilde{x}_h = x'_h$. Moreover, I can show that $(\varepsilon_h^*)' > \varepsilon_h^*$ by contradiction. Suppose that $(\varepsilon_h^*)' = \varepsilon_h^*$ and recall that there exists a $g$ such that $\Gamma'_h - \Gamma'_g > \Gamma_h - \Gamma_g, \forall g \in \{s,...,G\}$, for which:

$$(1 - F(\Gamma'_g - \Gamma'_h + \varepsilon_h^*)) > (1 - F(\Gamma_g - \Gamma_h + \varepsilon_h^*)).$$

As a result, $\tilde{a}(\Gamma'_h - \varepsilon_h^*, \Gamma') > \tilde{a}(\Gamma_h - \varepsilon_h^*, \Gamma)$, which contradicts $(\varepsilon_h^*)' = \varepsilon_h^*$. Hence, $H_h^\sigma(\tilde{x}_1,\Gamma) - H_h^\sigma(x'_1,\Gamma') < 0$, meaning there exists at most one equilibrium characterized by threshold strategies, which concludes *Step 1*.

*Step 2:* Next, I show that the system of indifference conditions given by:

$$H_g^\sigma(x_1,\Gamma) = 0, \forall g \in \{s,...,G\}$$

is well approximated by $H_g^0(x_1,\Gamma) = 0$, as $\sigma \searrow 0$. Note that $\lim_{\sigma\searrow 0}\xi = \lim_{\sigma\searrow 0}\vartheta(A,\Gamma) = 0$. Moreover, all group-specific signal thresholds $x_g^*$ must lie in the $\sigma/2$-neighborhood of the fundamental threshold $\theta^*(\sigma)$ for the indifference conditions to hold. Following Sákovics and Steiner (2012) I can show that $H_g^\sigma(x_1,\Gamma) = 0$ converges uniformly to $H_g^0(x_1,\Gamma)$ when $\sigma$ is small. To do so, I use the fact that the differential payoff from demanding conversion, $\Delta$, is Lipschitz continuous to the left and right of $\hat{A}(\theta)$.

*Step 3:* Next, I apply the Belief Constraint. Using the previous results, the signal thresholds $x_g^*$

converge to the fundamental threshold $\theta^*$ solving:

$$\int_0^{\frac{(\theta^*-1)r}{\kappa(\theta^*-r)}} ((\beta-\alpha-2\gamma_g)\tau_2-\tau_1)\, dA_g(A,\Gamma^*)$$
$$+\int_{\frac{(\theta^*-1)r}{\kappa(\theta^*-r)}}^1 \left(1+(\beta-\alpha-2\gamma_g)\tau_2-\tau_1-\frac{\frac{r-\kappa A}{r}\theta-\psi}{1-\kappa A}\right) dA_g(A,\Gamma^*)=0, \forall g\in\{s,...,G\}. \quad (28)$$

Summing over the coin holder groups on both sides, I arrive at Equation (12) using the Belief Constraint, which crucially depends on the assumption that the $\gamma_g$s are not contingent on the aggregate action of coin holders, to obtain:

$$\int_{\frac{(\theta^*-1)r}{\kappa(\theta^*-r)}}^1 \left(1-\frac{\frac{r-\kappa A}{r}\theta^*-\psi}{1-\kappa A}\right) dA+(\beta-\alpha)\tau_2-\tau_1-2\tau_2\frac{\mu_s m_s\gamma_s+\Sigma_{g=s+1}^G m_g\gamma_g}{\mu_s m_s+\Sigma_{g=s+1}^G m_g}=0,$$

where $\Sigma_{g=s+1}^G m_g A_g(A,\Gamma^*)+m_s\mu_s A_s(A,\Gamma^*)=A$.

It remains to establish the existence of a threshold equilibrium following iterated elimination of dominated strategies as in Sákovics and Steiner (2012). This concludes the Proof of Proposition 1.

### A.5.2 Proof of Proposition 2

I establish the comparative static results summarized in Proposition 2 by analyzing Equation (12):

$$\begin{aligned}
\frac{dI}{d\bar{\gamma}} &= -2\tau_2<0\\
\frac{dI}{d\beta} &= -\frac{dI}{d\alpha}=\tau_2>0\\
\frac{dI}{d\tau_1} &= -1<0\\
\frac{dI}{d\psi} &= \int_{\frac{(\theta^*-1)r}{\kappa(\theta^*-r)}}^1 \frac{\psi}{1-\kappa A}dA>0\\
\frac{dI}{dr} &= -\int_{\frac{(\theta^*-1)r}{\kappa(\theta^*-r)}}^1 \frac{\kappa A}{r^2(1-\kappa A)}\theta^* dA-\frac{\theta^*-1}{\kappa}\frac{\theta^*}{(\theta^*-r)^2}\left(1-1+\frac{\psi}{\frac{(\theta^*-1)r}{\kappa(\theta^*-r)}}\right)<0\\
\frac{dI}{d\kappa} &= \int_{\frac{(\theta^*-1)r}{\kappa(\theta^*-r)}}^1 \left(\frac{A}{(1-\kappa A)^2}\left(\frac{\theta^*}{r}-\psi\right)\right)dA+\frac{(\theta^*-1)r}{\kappa^2(\theta^*-r)}\left(1-1+\frac{\psi}{\frac{(\theta^*-1)r}{\kappa(\theta^*-r)}}\right)>0\\
\frac{dI}{d\tau_2} &= \beta-\alpha\\
\frac{dI}{d\theta^*} &= -\int_{\frac{(\theta^*-1)r}{\kappa(\theta^*-r)}}^1 \frac{\frac{r-\kappa A}{r}\theta^*-\psi}{1-\kappa A}dA-\frac{r}{\kappa}\frac{1-r}{(\theta^*-r)^2}\left(1-1+\frac{\psi}{1-\frac{(\theta^*-1)r}{\kappa(\theta^*-r)}}\right)<0.
\end{aligned}$$

By application of the implicit function theorem the results in Proposition 2 follow. This concludes the proof.

#### A.5.3 Proof of Proposition 3

The game is solved by backward induction. At time 2 consumers enter the consumption stage either as coin holders or as bank depositors and just use the available funds to consume. At time 1, consumers also enter the period either as coin holders or as depositors. Depositors do not find it optimal to convert their money at time 1, because they found it optimal to hold deposits initially and would otherwise forgo the positive interest rate. Given that the issuer can always assure a stablecoin value that is arbitrarily close to one dollar at time 2, it is the dominant strategy for active coin holders not to demand conversion, i.e. $a^*_{1,i} = 0, \forall i$. Requesting conversion at time 1 is unattractive due to the fixed conversion cost, as long as $\tau_1 > [\beta_i - \alpha_i]\tau_2$.

It remains to consider the adoption game at time 0. Given $r, \underline{\theta} \nearrow 1$, the consumer $i$'s problem is:

$$\max_{a_{0,i} \in \{0,1\}} \left( a_{0,i}(1 - \beta_i \tau_2) + (1 - a_{0,i})(1 + r^D - \alpha_i \tau_2) \right).$$

When deciding to adopt stablecoins at time 0, i.e. $a_{0,i} = 1$, consumer $i$ receives coins with a nominal value of \$1. Since the coins are safe, consumer $i$ can purchase one consumption good at time 2 from seller $\mathcal{A}$ and $C$, but only $1 - \tau_2$ units of the consumption good from seller $\mathcal{B}$. Instead, when deciding to keep the deposits at time 0, i.e. $a_{0,i} = 0$, and to hold them till time 2, consumer $i$ receives a (weakly) positive interest rate. Therefore, she can purchase $1 + r^D$ goods at time 2 from seller $\mathcal{B}$ and $C$, but only $1 + r^D - \tau_2$ goods from seller $\mathcal{A}$. This concludes the proof.

#### A.5.4 Proof of Proposition 5

For $\sigma \searrow 0$ social welfare is given by:

$$\begin{aligned} W(\theta^*; N) \equiv\; & (1 - N)(1 + r_d) - \left( \Sigma_{g=1}^{s-1} m_g \alpha_g + (1 - \mu_s) m_s \alpha_s \right) \tau_2 \\ & + \Sigma_{g=s+1}^{G} m_g \left( \int_{\underline{\theta}}^{\theta^*} \left( \kappa (1 - \tau_1 - \alpha_g \tau_2) + (1 - \kappa) \left( \frac{\frac{r-\kappa}{r}\theta - \psi}{1 - \kappa} - \beta_g \tau_2 \right) \right) d\theta + \int_{\theta^*}^{\overline{\theta}} (1 - \beta_g \tau_2) d\theta \right) \frac{1}{\overline{\theta} - \underline{\theta}} \\ & + \mu_s m_s \left( \int_{\underline{\theta}}^{\theta^*} \left( \kappa (1 - \tau_1 - \alpha_s \tau_2) + (1 - \kappa) \left( \frac{\frac{r-\kappa}{r}\theta - \psi}{1 - \kappa} - \beta_s \tau_2 \right) \right) d\theta + \int_{\theta^*}^{\overline{\theta}} (1 - \beta_s \tau_2) d\theta \right) \frac{1}{\overline{\theta} - \underline{\theta}}. \end{aligned} \tag{29}$$

Suppose the adoption rate is interior, i.e. $N \in (\Sigma_{g=j}^{G} m_g, \Sigma_{g=j-1}^{G} m_g)$, then the first derivative is given by:

$$\begin{aligned}
\frac{dW(\theta^*;N)}{dN} &= -(1+r_d-(\alpha+\gamma_s)\tau_2) \\
&+\Sigma_{g=s+1}^{G} m_g \frac{d\theta^*}{dN}\left(\kappa(1-\tau_1-\alpha_g\tau_2)+(1-\kappa)\left(1-\frac{\psi}{1-\kappa}-\beta_g\tau_2\right)-(1-\beta_g\tau_2)\right)\frac{1}{\overline{\theta}-\underline{\theta}} \\
&+\left(\int_{\underline{\theta}}^{\theta^*}\left(\kappa(1-\tau_1-\alpha_s\tau_2)+(1-\kappa)\left(\frac{\frac{r-\kappa}{r}\theta-\psi}{1-\kappa}-\beta_s\tau_2\right)\right)d\theta+\int_{\theta^*}^{\overline{\theta}}(1-\beta_s\tau_2)d\theta\right)\frac{1}{\overline{\theta}-\underline{\theta}} \\
&+\mu_s m_s \frac{d\theta^*}{dN}\left(\kappa(1-\tau_1-\alpha_s\tau_2)+(1-\kappa)\left(1-\frac{\psi}{1-\kappa}-\beta_s\tau_2\right)-(1-\beta_s\tau_2)\right)\frac{1}{\overline{\theta}-\underline{\theta}}.
\end{aligned}$$

Using an envelop-type argument, I evaluate the derivative at $N^*$ by plugging the indifference condition from the adoption game (Equation (14)):

$$\begin{aligned}
\frac{dW(\theta^*;N)}{dN}\Big|_{N=N^*} &= \Sigma_{g=s+1}^{G} m_g \frac{d\theta^*}{dN}\left(\kappa(-\tau_1-\alpha_g\tau_2)+(1-\kappa)\left(-\frac{\psi}{1-\kappa}-\beta_g\tau_2\right)+\beta_g\tau_2)\right)\frac{1}{\overline{\theta}-\underline{\theta}}\Big|_{N=N^*} \\
&+\mu_s m_s \frac{d\theta^*}{dN}\left(\kappa(-\tau_1-\alpha_s\tau_2)+(1-\kappa)\left(-\frac{\psi}{1-\kappa}-\beta_s\tau_2\right)+\beta_s\tau_2)\right)\frac{1}{\overline{\theta}-\underline{\theta}}\Big|_{N=N^*} < 0 \text{ if } \frac{d\theta^*}{dN} > 0.
\end{aligned}$$

As a result, $N^* > N^{SP}$ whenever the destabilizing composition effect from Corollary 1 is present, i.e. if $d\theta^*/dN > 0$, and the adoption rate is interior. This requires that consumers from more than one group adopt stablecoins.

It remains to discuss the case when adoption rate takes on a corner solution, i.e. $N^* \in \{\Sigma_{g=2}^{G} m_g, ..., \Sigma_{g=G-1}^{G} m_g\}$. From Equation (29) it can be seen that the two last terms drop when taking the derivative with respect to $N$ for the corner solution. However, adoption is still excessive as long as the destabilizing composition effect from Corollary 1 is present. This is the case if the marginal adopter is just indifferent. Otherwise, $N^* = N^{SP}$. This concludes the proof.

### A.5.5 Proof of Proposition 6

Building on the Proof of Proposition 5 and the analysis of the equilibrium in the two-stage game of the model with a network externality in Section 5.1, I analyze the first derivate of the the welfare function when $\alpha(N) = \chi N$. Again, suppose that the adoption rate is interior, i.e. $N \in$

$(\Sigma_{g=j}^{G} m_g, \Sigma_{g=j-1}^{G} m_g)$, then:

$$\begin{aligned}
\frac{dW(\theta^*;N)}{dN} &= -(1+r_d-(\alpha(N)+\gamma_s)\tau_2)-(1-N)\alpha'(N)\tau_2-\left(\Sigma_{g=s+1}^{G} m_g+\mu_s m_s\right)\int_{\underline{\theta}}^{\theta^*}\kappa\alpha'(N)\tau_2\frac{1}{\overline{\theta}-\underline{\theta}}d\theta \\
&+\Sigma_{g=s+1}^{G} m_g\frac{d\theta^*}{dN}\left(\kappa(1-\tau_1-\alpha_g\tau_2)+(1-\kappa)\left(1-\frac{\psi}{1-\kappa}-\beta_g\tau_2\right)-(1-\beta_g\tau_2)\right)\frac{1}{\overline{\theta}-\underline{\theta}} \\
&+\left(\int_{\underline{\theta}}^{\theta^*}\left(\kappa(1-\tau_1-\alpha_s\tau_2)+(1-\kappa)\left(\frac{\frac{r-\kappa}{r}\theta-\psi}{1-\kappa}-\beta_s\tau_2\right)\right)d\theta+\int_{\theta^*}^{\overline{\theta}}(1-\beta_s\tau_2)d\theta\right)\frac{1}{\overline{\theta}-\underline{\theta}} \\
&+\mu_s m_s\frac{d\theta^*}{dN}\left(\kappa(1-\tau_1-\alpha_s\tau_2)+(1-\kappa)\left(1-\frac{\psi}{1-\kappa}-\beta_s\tau_2\right)-(1-\beta_s\tau_2)\right)\frac{1}{\overline{\theta}-\underline{\theta}}.
\end{aligned}$$

Plugging in from the indifference condition gives:

$$\begin{aligned}
\frac{dW(\theta^*;N)}{dN}\Big|_{N=\check{N}^*} &= -\chi\left((1-N)\tau_2+\left(\Sigma_{g=s+1}^{G} m_g+\mu_s m_s\right)\int_{\underline{\theta}}^{\theta^*}\kappa\tau_2\frac{1}{\overline{\theta}-\underline{\theta}}d\theta\right)\Big|_{N=\check{N}^*} \\
&+\Sigma_{g=s+1}^{G} m_g\frac{d\theta^*}{dN}\left(\kappa(1-\tau_1-\alpha_g\tau_2)+(1-\kappa)\left(1-\frac{\psi}{1-\kappa}-\beta_g\tau_2\right)-(1-\beta_g\tau_2)\right)\frac{1}{\overline{\theta}-\underline{\theta}}\Big|_{N=\check{N}^*} \\
&+\mu_s m_s\frac{d\theta^*}{dN}\left(\kappa(1-\tau_1-\alpha_s\tau_2)+(1-\kappa)\left(1-\frac{\psi}{1-\kappa}-\beta_s\tau_2\right)-(1-\beta_s\tau_2)\right)\frac{1}{\overline{\theta}-\underline{\theta}}\Big|_{N=\check{N}^*},
\end{aligned}$$

where $\check{N}^*$ is the equilibrium level of adoption at the presence of positive network effects. The first line captures the additional terms, which are strictly negative for $\chi > 0$ and related to the uninternalized erosion of bank deposits as a means of payment. Observe that the derivative equals the one in the Proof of Proposition 5 if $\chi \searrow 0$.

Suppose that $\alpha(\check{N}^*) = \alpha$, then $\check{N}^* = N^*$ and $\check{N}^{SP} < N^{SP} < N^*$, provided the solution is interior. It is in this sense that the magnitude of the inefficiency increases when the second externality is introduced. Moreover, it increases in the magnitude of the network effect, i.e. in $\chi$. This concludes the proof of Proposition 6.

### A.5.6 Proof of Proposition 7

The proof establishes an example for $x^* = x_H < x^{SP}$ that arises for $x_L \searrow 0$ if the adoption rate is locally unaffected by changes in $x$, which is assured if $\gamma_s > \tilde{\gamma}$. To do so, I take the derivative of (18) with respect to $x_L$ and then examine the limit when $x_L \searrow 0$. First, note that $\pi(0) - \pi(x_H) = 0$ and:

$$\frac{d\pi(x_L)-\pi(x_H)}{dx_L} = \frac{d\overline{\theta}(x_L)}{dx_L}(\overline{\theta}(x_L)-1)\check{N}^*(x_L,\theta^*(x_L))\frac{d\theta}{\overline{\theta}(x)-\underline{\theta}(x)} - \int_{\theta^*(x_L)}^{\overline{\theta}(x_L)}(\theta-1)\check{N}^*(x_L,\theta^*(x_L))\frac{\frac{d\overline{\theta}(x_L)}{dx_L}-\frac{d\underline{\theta}(x_L)}{dx_L}}{\overline{\theta}(x)-\underline{\theta}(x)}d\theta,$$

where I used that $\check{N}^*$ is locally unaffected by changes in $x_L$ by assumption. Taking the limit gives:

$$\lim_{x_L\to 0}\frac{d\pi(x_L)-\pi(x_H)}{dx_L} = (R-\overline{\theta})(\overline{\theta}-1)\frac{N^*}{\overline{\theta}-\underline{\theta}}+\int_{\theta^*}^{\overline{\theta}}(\theta-1)\frac{N^*}{\overline{\theta}-\underline{\theta}}d\theta < 0.$$

As a result, the issuer optimally selects $x^* = x_H$ if $x_L \searrow 0$ and the adoption rate is locally unaffected by changes in $x$. This concludes the proof.

### A.5.7 Proof of Proposition 9

There are seven endogenous variables to keep track of, $\theta_1^*$, $\theta_2^*$, $N^*$, $r_\ell^*$, $s^*$, $\mu_s^*$ and $\tilde{\gamma}^*$. Notably, $\ell^*$, the additional endogenous variables $\gamma_\ell^*$ and $\mu_\ell^*$ are exclusively pinned down by $\delta$ from Equation (34).

I first consider the case where, due to the sparse distribution of groups, the adoption rate $N^*$ does not respond to small changes in $q$, $\kappa$, $\delta$ or in other model parameters. Said differently, I assume that $\nexists g$ s.t. $\gamma_g = \tilde{\gamma}^*$. Thereafter, I consider the case where $N^*$ responds to changes in model parameters, i.e. $\exists g$ s.t. $\gamma_g = \tilde{\tilde{\gamma}}^*$.

**Case 1: $\nexists g$ s.t. $\gamma_g = \tilde{\gamma}^*$.** Since $N^*$ does not respond to small changes in model parameters, I can conduct the comparative statics analysis for a given adoption rate $N$ and marginal group $s$, using the implicit function theorem. The derivatives of the first and second implicit function are:

$$\frac{dI_{\theta_1}(\cdot)}{d\theta_1^*} = -\frac{(1-r)r}{\left(\kappa - \frac{\delta}{N}\right)(\theta_1^* - r)^2} \frac{\psi}{\frac{\theta_1^*(1-r)}{\theta_1^*-r}} - \int_{\frac{\theta_1^*-1+\frac{\delta}{N}\left(1-\frac{\theta_1^*}{r}\right)}{\left(\kappa-\frac{\delta}{N}\right)(\theta_1^*-r)}r}^{1} \left( \frac{\frac{r-\frac{\delta}{N}-\left(\kappa-\frac{\delta}{N}\right)A}{r}}{1-\frac{\delta}{N}-\left(\kappa-\frac{\delta}{N}\right)A} \right) dA < 0$$

$$\frac{dI_{\theta_2}(\cdot)}{d\theta_2^*} < 0, \qquad \frac{dI_{\theta_1}}{d\theta_2^*}(\cdot) = \frac{dI_{\theta_2}}{d\theta_1^*}(\cdot) = \frac{dI_{\theta_z^*}}{dr_\ell}(\cdot) = \frac{dI_{\theta_z}}{dq}(\cdot) = 0, \forall z = 1,2.$$

Moreover, given $\mu_s = 0$:

$$\frac{dI_{\theta_1}(\cdot)}{d\kappa} = -2\overbrace{\frac{d\overline{\gamma}(\ell;N,\delta)}{d\kappa}}^{=0}\tau_2 + \frac{\theta_1^*-1+\frac{\delta}{N}\left(1-\frac{\theta_1^*}{r}\right)}{\left(\kappa-\frac{\delta}{N}\right)^2(\theta_1^*-r)} \frac{\psi}{\frac{\theta_1^*(1-r)}{\theta_1^*-r}} - \int_{\frac{\theta_1^*-1+\frac{\delta}{N}\left(1-\frac{\theta_1^*}{r}\right)}{\left(\kappa-\frac{\delta}{N}\right)(\theta_1^*-r)}r}^{1} \left( \frac{\frac{A}{N}\left(\theta_1^*\left(1-\frac{1}{r}\right)-\psi\right)}{\left(1-\frac{\delta}{N}-\left(\kappa-\frac{\delta}{N}\right)A\right)^2} \right) dA > 0$$

$$\frac{dI_{\theta_1}(\cdot)}{d\delta} = -2\overbrace{\frac{d\overline{\gamma}(\ell;N,\delta)}{d\delta}}^{<0}\tau_2 + \frac{\frac{\kappa}{N}(\theta_1^*-1)+\frac{\kappa}{N}\left(1-\frac{\theta_1^*}{r}\right)}{\left(\kappa-\frac{\delta}{N}\right)^2(\theta_1^*-r)} \frac{\psi}{\frac{\theta_1^*(1-r)}{\theta_1^*-r}} - \int_{\frac{\theta_1^*-1+\frac{\delta}{N}\left(1-\frac{\theta_1^*}{r}\right)}{\left(\kappa-\frac{\delta}{N}\right)(\theta_1^*-r)}r}^{1} \left( \frac{\frac{1}{N}\left(\theta_1^*\left(1-\frac{1}{r}\right)-\psi\right)}{\left(1-\frac{\delta}{N}-\left(\kappa-\frac{\delta}{N}\right)A\right)^2} \right) dA > 0$$

$$\frac{dI_{\theta_2}(\cdot)}{d\kappa} = -2\overbrace{\frac{d\overline{\gamma}(\ell;N,\delta)}{d\kappa}}^{=0}\tau_2 + \frac{\theta_2^*-1}{\left(\kappa-\frac{\delta}{N}\right)^2(\theta_2^*-r)} \frac{\psi}{\frac{\theta_2^*(1-r)}{\theta_2^*-r}} - \int_{\frac{\theta_1^*-1}{\left(\kappa-\frac{\delta}{N}\right)(\theta_1^*-r)}r}^{1} \left( \frac{\frac{A\theta_2^*}{N}\left(1-\frac{1}{r}\right)-\psi\frac{A}{N}}{\left(1-\frac{\delta}{N}-\left(\kappa-\frac{\delta}{N}\right)A\right)^2} \right) dA > 0$$

$$\frac{dI_{\theta_2}(\cdot)}{d\delta} = -2\overbrace{\frac{d\overline{\gamma}(\ell;N,\delta)}{d\delta}}^{<0}\tau_2 - \frac{1}{N}\frac{\theta_2^*-1}{\left(\kappa-\frac{\delta}{N}\right)^2(\theta_2^*-r)}r\frac{\psi}{\frac{\theta_2^*(1-r)}{\theta_2^*-r}}$$
$$-\int_{\frac{\theta_1^*-1}{\left(\kappa-\frac{\delta}{N}\right)(\theta_1^*-r)}r}^{1}\left(\frac{A\frac{A\theta_2^*}{Nr}(1-r)+\psi\frac{A}{N}}{\left(1-\left(\kappa-\frac{\delta}{N}\right)A\right)^2}\right)dA < 0 \text{ if } d\overline{\gamma}/d\delta \text{ is small}$$

The derivatives of the third implicit function are:

$$\frac{d\Delta^\ell(\cdot)}{d\theta_1^*} = q\left( (\kappa+r_\ell)\frac{\frac{r-\kappa}{r}\theta_1^*-\psi}{1-\kappa} - \kappa(1-\tau_1-\alpha_{g_i}\tau_2)-r_\ell \right) < 0$$
$$\frac{d\Delta^\ell(\cdot)}{d\theta_2^*} = (1-q)\left( (\kappa+r_\ell)\frac{\frac{r-\kappa+\frac{\delta}{N}}{r}\theta_1^*-\psi}{1-\kappa+\frac{\delta}{N}} - \kappa(1-\tau_1-\alpha_{g_i}\tau_2)-r_\ell \right) < 0$$

and:

$$\frac{d\Delta^\ell(\cdot)}{d\kappa} = q\left( \int_{\underline{\theta}}^{\theta_1^*}\left(\frac{\frac{r-\kappa}{r}\theta_1-\psi}{1-\kappa} + (\kappa+r_\ell)\frac{-\frac{\theta_1}{r}(1-\kappa)+\frac{r-\kappa}{r}\theta-\psi}{(1-\kappa)^2} - (1-\tau_1-\alpha_{g_i}\tau_2)+\kappa\tau_2\frac{d\overline{\gamma}}{d\kappa}\right)d\theta \right)$$
$$+(1-q)\left( \int_{\underline{\theta}}^{\theta_2^*}\left(\frac{\frac{r-\kappa+\frac{\delta}{N}}{r}\theta_2-\psi}{1-\kappa+\frac{\delta}{N}} + (\kappa+r_\ell)\frac{-\frac{\theta_2}{r}(1-\kappa+\frac{\delta}{N})+\frac{r-\kappa+\frac{\delta}{N}}{r}\theta_2-\psi}{(1-\kappa+\frac{\delta}{N})^2} - (1-\tau_1-\alpha_{g_i}\tau_2)+\kappa\tau_2\frac{d\overline{\gamma}}{d\kappa}\right)d\theta \right) < 0$$
$$\frac{d\Delta^\ell(\cdot)}{d\delta} = q\left( \int_{\underline{\theta}}^{\theta_1^*}\left(\kappa\tau_2\frac{d\overline{\gamma}}{d\delta}\right)d\theta \right) + (1-q)\left( \int_{\underline{\theta}}^{\theta_2^*}\left((\kappa+r_\ell)\frac{(1-r)\frac{\kappa\theta}{Nr}+\kappa\psi}{(1-(1-\delta)\kappa)^2}+\kappa\tau_2\frac{d\overline{\gamma}}{d\delta}\right)d\theta \right) > 0 \text{ if } q\searrow 0$$
$$\frac{d\Delta^\ell(\cdot)}{dr_\ell^*} = q\left( \int_{\underline{\theta}}^{\theta_1^*}\left(\frac{\frac{r-\kappa}{r}\theta-\psi}{1-\kappa}\right)d\theta + \int_{\theta_1^*}^{\overline{\theta}}d\theta \right) + (1-q)\left( \int_{\underline{\theta}}^{\theta_2^*}\left(\frac{\frac{r-\kappa+\frac{\delta}{N}}{r}\theta-\psi}{1-\kappa+\frac{\delta}{N}}\right)d\theta + \int_{\theta_2^*}^{\overline{\theta}}d\theta \right) > 0$$
$$\frac{d\Delta^\ell(\cdot)}{dq} < 0,$$

where $d\overline{\gamma}/d\kappa = 0$ and $d\overline{\gamma}/d\delta = 0$ by assumption.

Note that $I_{\theta_1}$, $I_{\theta_2}$ and $\Delta^\ell$ are continuously differentiable. Using the implicit function theorem for simultaneous equations, I can derive:

$$\frac{d\theta_1^*}{dvar} = \frac{\begin{vmatrix} -\frac{dI_{\theta_1}}{dvar} & \frac{dI_{\theta_1}}{d\theta_2^*} & \frac{dI_{\theta_1}}{dr_\ell^*} \\ -\frac{dI_{\theta_2}}{dvar} & \frac{dI_{\theta_2}}{d\theta_2^*} & \frac{dI_{\theta_2}}{dr_\ell^*} \\ -\frac{d\Delta^\ell}{dvar} & \frac{d\Delta^\ell}{d\theta_2^*} & \frac{d\Delta^\ell}{dr_\ell^*} \end{vmatrix}}{|D|}, \tag{30}$$

where *var* is the exogenous variable of interest. The determinant is non-zero and given by:

$$|D| \equiv \begin{vmatrix} \frac{dI_{\theta_1}}{d\theta_1^*} & \frac{dI_{\theta_1}}{d\theta_2^*} & \frac{dI_{\theta_1}}{dr_\ell^*} \\ \frac{dI_{\theta_2}}{d\theta_1^*} & \frac{dI_{\theta_2}}{d\theta_2^*} & \frac{dI_{\theta_2}}{dr_\ell^*} \\ \frac{d\Delta^\ell}{d\theta_1^*} & \frac{d\Delta^\ell}{d\theta_2^*} & \frac{d\Delta^\ell}{dr_\ell^*} \end{vmatrix} > 0. \tag{31}$$

First, I find that $d\theta_z^*/dq = 0, \forall z = 1,2$, because the flightiness of coin holders participating in the conversion game is only affected by $\delta$ and not by $q$. However, the remuneration of stablecoin lenders is affected. Specifically, they need to be offered a higher compensation $dr_\ell^*/dq > 0$ due to the reduced stability, which reduces the attractiveness of stablecoin lending.

Second, I find that $d\theta_1^*/d\kappa > 0$ and $d\theta_2^*/d\kappa > 0$, which again results in the need for a higher compensation in the lending game, $\lim_{q\to 0} dr_\ell^*/d\kappa > 0$. Moreover, $\lim_{q\to 0} d\theta_1^*/d\delta > 0$, $\lim_{q\to 0} d\theta_2^*/d\delta < 0$ and $\lim_{q\to 0} dr_\ell^*/d\delta < 0$ provided $d\overline{\gamma}/d\delta$ is small.

Notably, $\tilde{\gamma}^*$, and consequently also $s^*$ and $N^*$, are derived from $\Delta^0(\theta_1^*, \theta_2^*; \gamma_{s^*}) = 0$ without effect on the qualitative results derived above, provided $\nexists g$ s.t. $\gamma_g = \tilde{\gamma}^*$. Or put another way, $\gamma_s > \tilde{\gamma}^*$.

**Case 2: $\exists g$ s.t. $\gamma_g = \tilde{\gamma}^*$.** Next, I conduct the comparative statics analysis allowing for a change in the adoption rate. This means that $s^*$ is defined by $\gamma_s = \tilde{\gamma}^*$. Hence, both variables respond to small changes in model parameters whenever these changes are not off-set by changes in $\mu_s^*$, which necessitates changes in $N^*$. As a result, I can take $s$ and $\gamma_s$ as given when analyzing how $N^*$ and $\mu_s^*$ change as prescribed by $\Delta^0(\theta_1^*, \theta_2^*; \gamma_s, \mu_s) = 0$ and $N^*(s, \mu_s^*) = \Sigma_{g=s+1}^G m_g + \mu_s^* m_s$. Thereby, I use the previous insight that $\Delta_i^0$ is independent of $\ell$ and of $r_\ell$ for $\ell > s$.

I start by analyzing the following additional derivatives:

$$
\begin{aligned}
\frac{dI_{\theta_1}(\cdot)}{dN^*} &= -2\tau_2 \overbrace{\frac{d\overline{\gamma}(\delta)}{dN^*}}^{<0} - \frac{\delta r}{(N^*)^2} \frac{\theta_1^*\left(\frac{1}{r}-1\right)}{\left(\kappa - \frac{\delta}{N}\right)^2 (\theta_1^* - r)} r \left( \frac{\psi}{1 - \frac{\delta}{N} - \frac{\theta_1^* - 1 + \frac{\delta}{N}\left(1 - \frac{\theta_1^*}{r}\right)}{\theta_1^* - r} r} \right) dA \\
&\quad - \int_{\frac{\theta_1^* - 1 + \frac{\delta}{N}\left(1 - \frac{\theta_1^*}{r}\right)}{\left(\kappa - \frac{\delta}{N}\right)(\theta_1^* - r)} r}^{1} \left( \frac{\frac{\frac{\delta}{N^2}(1-A)}{r}\theta_1^* - \frac{\delta}{N^2}(1-A)(\theta_1^* - \psi)}{\left(1 - \frac{\delta}{N} - \left(\kappa - \frac{\delta}{N}\right) A\right)^2} \right) dA < 0 \text{ if } d\overline{\gamma}(\delta)/dN^* \text{ is small} \\
\frac{dI_{\theta_2}(\cdot)}{dN^*} &= -2\tau_2 \overbrace{\frac{d\overline{\gamma}(\delta)}{dN^*}}^{<0} + \frac{\delta r}{(N^*)^2} \frac{\theta_2^* - 1}{\left(\kappa - \frac{\delta}{N}\right)^2 (\theta_2^* - r)} r \left( \frac{\psi}{1 - \frac{\theta_2^* - 1}{\theta_2^* - r} r} \right) dA \\
&\quad - \int_{\frac{\theta_2^* - 1}{\left(\kappa - \frac{\delta}{N}\right)(\theta_2^* - r)} r}^{1} \left( \frac{-\frac{\delta}{rN^2} A \theta_2^* + \frac{\delta}{N^2} A (\theta_2^* - \psi)}{\left(1 - \left(\kappa - \frac{\delta}{N}\right) A\right)^2} \right) dA > 0
\end{aligned}
$$

Note that both derivatives are approximately zero in the limit $\delta \to 0$. Moreover:

$$
\begin{aligned}
\frac{d\Delta^\ell(\cdot)}{dN^*} &= q \int_{\underline{\theta}}^{\theta_1^*} \kappa \tau_2 \frac{d\overline{\gamma}(\delta)}{dN^*} d\theta \;\; + (1-q) \int_{\underline{\theta}}^{\theta_2^*} \left( \kappa \tau_2 \frac{d\overline{\gamma}(\delta)}{dN^*} + (1-\kappa) \frac{\frac{\delta}{rN^2}\theta\left(1 - \frac{1}{r}\right) - \psi}{\left(1 - \kappa + \frac{\delta}{N}\right)^2} \right) d\theta \;\; < 0 \\
\frac{d\Delta^0(\cdot)}{d\theta_1^*} &= q \left( \kappa(1 - \tau_1 - \alpha_{g_i}\tau_2) + (1-\kappa) \left( \frac{\frac{r-\kappa}{r}\theta_1^* - \psi}{1-\kappa} - \beta_{g_i}\tau_2 \right) - (1 - \beta_{g_i}\tau_2) \right) < 0 \\
\frac{d\Delta^0(\cdot)}{d\theta_2^*} &= (1-q) \left( \kappa(1 - \tau_1 - \alpha_{g_i}\tau_2) + (1-\kappa) \left( \frac{\frac{r-\kappa+\frac{\delta}{N}}{r}\theta_2^* - \psi}{1 - \kappa + \frac{\delta}{N}} - \beta_{g_i}\tau_2 \right) - (1 - \beta_{g_i}\tau_2) \right) < 0
\end{aligned}
$$

and:

$$
\begin{aligned}
\frac{d\Delta^0(\cdot)}{dq} &= \left(\int_{\underline{\theta}}^{\theta_1^*}\left(\kappa(1-\tau_1-\alpha_{g_i}\tau_2)+(1-\kappa)\left(\frac{\frac{r-\kappa}{r}\theta_1-\psi}{1-\kappa}-\beta_{g_i}\tau_2\right)\right)d\theta+\int_{\theta_1^*}^{\overline{\theta}}(1-\beta_{g_i}\tau_2)d\theta\right) \\
&\quad -\left(\int_{\underline{\theta}}^{\theta_2^*}\left(\kappa(1-\tau_1-\alpha_{g_i}\tau_2)+(1-\kappa)\left(\frac{\frac{r-\kappa+\frac{\delta}{N}}{r}\theta_2-\psi}{1-\kappa+\frac{\delta}{N}}-\beta_{g_i}\tau_2\right)\right)d\theta+\int_{\theta_2^*}^{\overline{\theta}}(1-\beta_{g_i}\tau_2)d\theta\right)<0 \\
\frac{d\Delta^0(\cdot)}{d\kappa} &= q\int_{\underline{\theta}}^{\theta_1^*}\left(1-\tau_1-\alpha_{g_i}\tau_2-\frac{\frac{r-\kappa}{r}\theta_1-\psi}{1-\kappa}+\beta_{g_i}\tau_2+(1-\kappa)\frac{-\frac{1}{r}\theta_2\left(1-\kappa\right)+\frac{r-\kappa}{r}\theta_1-\psi}{\left(1-\kappa\right)^2}\right)d\theta \\
&\quad +(1-q)\int_{\underline{\theta}}^{\theta_2^*}\left(1-\tau_1-\alpha_{g_i}\tau_2-\frac{\frac{r-\kappa+\frac{\delta}{N}}{r}\theta_2-\psi}{1-\kappa+\frac{\delta}{N}}+\beta_{g_i}\tau_2+(1-\kappa)\frac{-\frac{\theta_2(1-\kappa+\frac{\delta}{N})}{r}+\frac{r-\kappa++\frac{\delta}{N}}{r}\theta_2-\psi}{1-\kappa+\frac{\delta}{N}}\right)d\theta \gtrless 0 \\
\frac{d\Delta^0(\cdot)}{d\delta} &= \frac{d\overline{\gamma}}{d\delta}\tau_2+q\left(\int_{\underline{\theta}}^{\theta_1^*}\left(-\kappa\frac{d\overline{\gamma}}{d\delta}\tau_2+(1-\kappa)\frac{d\overline{\gamma}}{d\delta}\tau_2\right)d\theta+\int_{\theta_1^*}^{\overline{\theta}}\frac{d\overline{\gamma}}{d\delta}\tau_2 d\theta\right) \\
&\quad +(1-q)\left(\int_{\underline{\theta}}^{\theta_2^*}\left(-\kappa\frac{d\overline{\gamma}}{d\delta}\tau_2+(1-\kappa)\left(\frac{\frac{\theta_2}{N}\left(\frac{1}{r}-1\right)+\frac{\psi}{N}}{1-\kappa+\frac{\delta}{N}}+\frac{d\overline{\gamma}}{d\delta}\tau_2\right)\right)d\theta+\int_{\theta_2^*}^{\overline{\theta}}\frac{d\overline{\gamma}}{d\delta}\tau_2 d\theta\right)>0 \text{ if } \frac{d\overline{\gamma}}{d\delta} \text{ is small}
\end{aligned}
$$

$$
\begin{aligned}
\frac{d\Delta^0(\cdot)}{dr_\ell^*} &= 0 \\
\frac{d\Delta^0(\cdot)}{dN^*} &= \frac{d\overline{\gamma}}{dN^*}\tau_2+q\left(\int_{\underline{\theta}}^{\theta_1^*}(1-2\kappa)d\theta+\int_{\theta_1^*}^{\overline{\theta}}d\theta\right)\frac{d\overline{\gamma}}{dN^*}\tau_2+(1-q)\left(\int_{\underline{\theta}}^{\theta_2^*}(1-2\kappa)d\theta+\int_{\theta_2^*}^{\overline{\theta}}d\theta\right)\frac{d\overline{\gamma}}{dN^*}\tau_2 \\
&\quad +(1-q)\int_{\underline{\theta}}^{\theta_2^*}\frac{\frac{\delta\theta_2}{rN^2}\left(1-\frac{1}{r}\right)-\frac{\delta}{N^2}\psi}{\left(1-\kappa+\frac{\delta}{N}\right)^2}d\theta<0,
\end{aligned}
$$

where $d\overline{\gamma}/dN^*<0$ and $d\overline{\gamma}/dN^*<0$ for all $s\leq G-1$.

Next, I apply the implicit function theorem for simultaneous equations to analyze the system comprising $I_{\theta_1}(\cdot)=0$, $I_{\theta_1}(\cdot)=0$ and $\Delta^0(\cdot)=0$. Note that also $\Delta^0(\cdot)$ is continuously differentiable. Different to before, the determinant is now non-zero and negative.

First, I find that $d\theta_2^*/dq<0$ and $dN^*/dq<0$. Moreover, $d\theta_1^*/dq>0$ if $d\overline{\gamma}(\delta)/dN$ is small. Intuitively, the flightiness of coin holders participating in the conversion game is affected by $\delta$ and by $q$ through its effect on the pro-rata residual value of the insolvent issuer that arises because the borrower borrows a fixed amount. Stability is reduced when the likelihood of the borrower being a speculator increases, which decreases adoption by making stablecoins less attractive.

Second, I find that $\lim_{\delta\to 0}d\theta_1^*/d\kappa>0$ and $\lim_{\delta\to 0}d\theta_2^*/d\kappa>0$. Moreover, $\lim_{q\to 0,\delta\to 0}d\theta_1^*/d\delta>0$, as well as $\lim_{q\to 0,\delta\to 0}d\theta_2^*/d\delta<0$ and $\lim_{q\to 0}dN^*/d\delta>0$ provided $d\overline{\gamma}/d\delta$ is small. This concludes the proof. The results are summarized in Proposition 9.

### A.5.8 Proof of Proposition 10

This proof comprises two parts and builds on results from the Proof of Proposition 2. We discuss *Part (a)* and *Part (b)* of the Proof of Proposition 10 in turn.

*Part (a):* The issuer cannot meet its $t = 2$ payment obligations if $N(\kappa(1-A)+1-\kappa) > (N-\xi)\theta - N\kappa A\theta/r$. Rearranging gives $\hat{A}(\theta;N,\xi)$ in Equation (22). Using the modified critical threshold in Equation (22), we can for a given $N$ derive the modified equilibrium condition as follows:

$$I(\theta^*;N,\xi) \equiv (\beta-\alpha(N)-2\overline{\gamma})\tau_2-\tau_1+\int_{\frac{\frac{N-\xi}{N}\theta^*-1}{\kappa(\theta^*-r)}r}^{1}\left(1-\frac{\frac{\frac{N-\xi}{N}r-\kappa A}{r}\theta^*-\psi}{1-\kappa A}\right)dA = 0. \tag{32}$$

As in the Proof of Proposition 2 we have that $dI(\theta^*;N,\xi)/d\theta^* < 0$. Moreover:

$$\frac{dI(\theta^*;N,\xi)}{d\xi} = -\int_{\frac{\frac{N-\xi}{N}\theta^*-1}{\kappa(\theta^*-r)}r}^{1}\left(-\frac{1}{1-\kappa A}\frac{\theta^*}{N}\right)dA+\frac{\theta^* r}{N\kappa(\theta^*-r)}\left(\frac{\psi}{1-\kappa\hat{A}}\right) > 0.$$

By application of the implicit function theorem we have that $d\theta^*/d\xi > 0$.

*Part (b):* The issuer cannot meet its $t = 2$ payment obligations if $N(\kappa(1-A)+1-\kappa) > N\theta - N\kappa A(1-f\tau_1)\theta/r$.[29] Rearranging gives $\hat{A}(\theta;N,f)$ in Equation (24), which is unique as long as $f\tau_1$ is not too large.

The equilibrium fundamental threshold $\theta^*(N^*;f)$ is governed by a modified equilibrium condition from the $t = 1$ conversion game:

$$I(\theta^*;f) \equiv (\overline{\beta}-\overline{\alpha})\tau_2-\tau_1+\int_{\frac{\theta^*-1}{\theta^*(1-f\tau_1)-r}\frac{r}{\kappa}}^{1}\left(1-\frac{\frac{r-\kappa A(1-f\tau_1)}{r}\theta^*+(1-\kappa A)\overline{\beta}_f(A)f\tau_2-\psi}{1-\kappa A}\right)dA = 0, \tag{33}$$

where $\overline{\beta}_f(A)$ takes into account that the transaction fee income at $t = 2$ is only generated from the coin holders not demanding conversion at $t = 1$, i.e. the coin holders belonging to groups with a sufficiently high level of $\alpha_g - \beta_g$ (where $\overline{\beta}_f(1) = \overline{\beta}$). Note that the case with $f = 0$ nests our benchmark model.

As in the Proof of Proposition 2 we have that $dI(\theta^*;f)/d\theta^* < 0$. Moreover:

$$\frac{dI(\theta^*;f)}{df} = -\int_{\frac{\theta^*-1}{\theta^*(1-f\tau_1)-r}\frac{r}{\kappa}}^{1}\left(\frac{\frac{\kappa A\tau_1}{r}\theta^*-(1-\kappa A)\overline{\beta}_f(A)\tau_2}{1-\kappa A}\right)dA-\frac{\theta^*-1}{(\theta^*(1-f\tau_1)-r)^2}\frac{r\theta^*\tau_1}{\kappa}\frac{\psi-(1-\kappa\hat{A})\overline{\beta}_f(\hat{A})f\tau_2}{1-\kappa\hat{A}},$$

which is negative provided $f$ and $\tau_2$ are not too large. By application of the implicit function theorem we have that $d\theta^*/df < 0$ provided $f$ and $\tau_2$ are not too large. This concludes the proof.

[29]Observe that we assume that the revenue from the $t = 2$ transaction fees does not count against the payment obligation, e.g because it does not accrue in time. This assumption simplifies the analysis.

## A.6 Description of the Extension with Stablecoin Lending and Timeline

**Modified stablecoin conversion game at $t = 1$.** As before, the model is solved backwards. In the conversion game played by the remaining active coin holders, I now distinguish between the state $z = 1$, when it is observed that the borrower is a speculator who has demanded conversion, and the state $z = 2$, when it is observed that she has not demanded conversion (i.e., she keeps her coins until $t = 2$). Appendix Section A.7.1 analyzes the equilibrium conditions for the both states, deriving the equations for $\theta_1^*$ and $\theta_2^*$.

**Stablecoin lending game at the end of $t = 0$.** In the newly introduced stablecoin lending game the borrower makes a take-it-or-leave-it-offer to coin holders, who do not yet know whether they will be active or passive at $t = 1$. The borrower promises each coin holder to return $1 + r_\ell$ stablecoins at $t = 2$ for each coin lent out at the end of $t = 0$. The offer does not depend on the borrower's motive, which is revealed at $t = 1$. Since the borrower is unconstrained, stablecoin lenders face no credit risk in the sense that they always receive the promised amount of stablecoins at $t = 2$.[30] I show in Appendix Section A.7.2 that the borrower optimally makes an offer that allows her to borrow the desired amount $\delta$ at the lowest cost by calibrating $r_\ell$ such that just enough coin holders are willing to participate. Importantly, coin holders belonging to a group with a higher induced payment preference for stablecoins have a higher incentive to engage in stablecoin lending. Intuitively, this is because they benefit less from having the option to demand conversion at $t = 1$.[31]

**Modified stablecoin adoption game at the beginning of $t = 0$.** Consumers recognize that there are opportunities and risks associated with the introduction of stablecoin lending. The modified adoption game is developed formally in Appendix Section A.7.3 and the modified timeline is shown in Table A3.

The analysis of the stablecoin lending game rests on two important assumptions. First, I assume throughout that the borrower is willing to offer costly incentives that allow her to collect $\delta$ stablecoins, regardless of whether she is a speculator or not. Second, the borrowing volume $\delta$ is assumed to be fixed. If $\delta$ is allowed to vary, then the borrower without a speculative motive may be able to signal her type by borrowing less. However, the existence of a separating equilibrium is not guaranteed. Another important assumption relates to information and timing. Unlike Corsetti et al. (2004), I do not consider a speculator who has private information about $\theta$, but an uninformed speculator who always demands conversion.

[30] This assumption is plausible and can be rationalized with smart contracts.

[31] It is plausible that most of the deposit activity is, in practice, conducted by individuals who may be seen as crypto enthusiasts. In the model these are the consumers belonging to groups with high levels of $\gamma_g$. I revisit this empirical question in Section 6.

| Date 0 | Date 1 | Date 2 |
|---|---|---|
| 1. **Adoption game:** Consumer simultaneously decide whether to convert their bank deposits to stablecoins, $a_{0,i} = 1$, or not, , $a_{0,i} = 0$<br>2. The stablecoin issuer invests all funds received from consumers who adopt stablecoins<br>3. **Stablecoin lending game:** The borrower makes a take-it-or-leave-it offer to coin holders, who simultaneously decide whether to lend their coins, $a'_{0,i} = 1$, or not, $a'_{0,i} = 0$, given the promise of the borrower to return $1 + r_\ell$ coins at $t = 2$ | 4. W.p. $q$ the borrower is a speculator who demands conversion and w.p. $1 - q$ she is no speculator and does not demand conversion<br>5. In case the borrower demands conversion, the issuer liquidates assets to meet redemption requests<br>6. The fundamental $\theta$ is realized but unobserved and a fraction $\kappa$ of coin holders become active<br>7. **Stablecoin conversion game:** The remaining active coin holders receive private information $x_i$ and simultaneously decide whether to demand conversion to deposits, $a_{1,i} = 1$, or not, $a_{1,i} = 0$, while passive coin holders are dormant<br>8. The stablecoin issuer meets coin holders' conversion requests by divesting assets | 9. The outcome of the $t = 1$ stablecoin conversion game and the fundamental realization $\theta$ are observed<br>10. The borrower returns the stablecoins plus interest to lenders and the stablecoin issuer meets her payment obligations to the remaining active and passive coin holders, including by minting new coins against cash from the borrower; if insolvent, the issuer disburses the available resources pro rata<br>10a. Consumers buy goods from their preferred seller and convert their money (if necessary)<br>10b. Sellers A and C convert the stablecoins earned; all sellers pay production costs with government-backed deposits (or dollars) |

Table A3: Timeline of events with stablecoin lending.

## A.7 Derivations for the Extension with Stablecoin Lending

To simplify the analysis of the extended model I consider the case without positive network effects, i.e. $\alpha'(N) = 0$. Sections A.7.1, A.7.2 and A.7.3 study the modified conversion game, the stablecoin lending game and the modified adoption game. Section A.5.7 develops the Proof of Proposition 9.

### A.7.1 The Modified Stablecoin Conversion Game at $t = 1$

The participation in the stablecoin game affects the composition of the population of active coin holders playing the conversion game at $t = 1$. Intuitively, coin holders belonging to a group with a high level of $\gamma_g$ benefit less from the option to demand conversion at $t = 1$, as shown below. Let $\ell \in \{s + 1, G\}$ be the group of coin holders with the smallest probability of meeting a seller who has a preference for stablecoin payments among the groups of coin holders who are willing to participate in stablecoin lending. Hence, $\ell$ and $\mu_\ell$ are for a given $\delta$ determined as:

$$\delta \quad = \quad \arg\max_{\ell} \left( \Sigma_{g=\ell+1}^{G} m_g \mathbb{1}_{\ \gamma_g > \gamma_\ell} + \mu_\ell m_\ell \right), \tag{34}$$

where $\mu_\ell \in [0,1]$ is smaller than one if the borrower does not need all (of the indifferent) coin holders in group $\ell$ to participate. Note that the initial assumption $\delta \in (0, \kappa N)$ implies that $\ell \geq s$. Moreover, the expression in brackets on the right-hand side of Equation (34) is monotonically decreasing in $\ell$ and increasing in $\mu_\ell$. It is maximized by the lowest possible $\ell$, meaning that (34) defines $\gamma_\ell$ and $\mu_\ell$.

As a result, the composition of the remaining active coin holder is modified as follows:

$$\overline{\gamma}(\delta) \quad \equiv (\mu_s m_s \gamma_s + \Sigma_{g=s+1}^{\ell-1} m_g \gamma_g + (1-\mu_\ell) m_\ell \gamma_\ell) / (\mu_s m_s + \Sigma_{g=s+1}^{\ell-1} m_g + (1-\mu_\ell) m_\ell).$$

Throughout the analysis I focus on the interesting case where Assumption 2 holds, which is an extension of Assumption 1 for the model with stablecoin lending.

**Assumption 2.** *Let* $\underline{\theta} < 1 - \sigma\, \epsilon$, $r/(r-\kappa) + \sigma\, \epsilon < \overline{\theta}$, $\delta < \kappa < r - \psi r/\underline{\theta}$ *and* $\psi \in (\underline{\psi}, \underline{\theta} - \beta_1 \tau_2 \kappa)$.

The new bounds on $\kappa$ and $\delta$ in Assumption 2 assure that the issuer can always fully meet the redemption requests of the speculator, meaning that the speculator is not too large. Otherwise, the issuer would deplete all resources and be insolvent prior to the conversion game. This is because solvency, i.e. no rationing, at $t = 1$ now requires that $N(\kappa - \delta/N) + \delta < Nr$ and the new condition for weakly positive profits is given by:

$$\frac{\frac{r - \frac{\delta}{N} - (\kappa - \frac{\delta}{N})A}{r}\theta - \psi}{1 - (\kappa - \frac{\delta}{N})A} - \beta_g \tau_2 > 0, \forall g \in \{1, ..., G\}, \theta \in [\underline{\theta}, \overline{\theta}],$$

which holds if $\psi < \underline{\theta} - \beta_1 \tau_2 \kappa$ and $\kappa \leq r - \psi r/\underline{\theta}$.

Note that $\overline{\Delta}_i(\theta, \delta) > 0, \forall \theta \in (\theta_\ell, \theta_h), g_i \in \{s, ..., G\}$ if:

$$\psi > ((\beta_G - \alpha_G)\tau_2 + \tau_1)(1 - (\kappa - \delta/N)) \geq \underline{\psi}, \forall N \in [0,1],$$

where I used $\theta_h(\delta, N) \equiv (1 - (\kappa - \delta/N)) r/(r-\kappa) < r/(r-\kappa), \forall N \in [0,1]$ such that $\delta < \kappa N$.

**State $z = 1$: Borrower is a speculator.** Due to the conversion demand by the speculator at the beginning of $t = 1$, the critical threshold $\hat{A}_1(N; \theta, \kappa, \delta)$ has to be modified:

$$\hat{A}_1(N; \theta_1, \delta) \equiv \frac{\theta_1 - 1 + \frac{\delta}{N}\left(1 - \frac{\theta_1}{r}\right)}{\left(\kappa - \frac{\delta}{N}\right)(\theta_1 - r)} r \tag{35}$$

and the indifference condition is now given by:

$$\Delta_{i,1}(A; \theta_1, N, \delta) = \begin{cases} (\beta_{g_i} - \alpha_{g_i})\tau_2 - \tau_1 & \text{if } A \leq \hat{A}_1(N; \theta_1, \delta) \\ 1 + (\beta_{g_i} - \alpha_{g_i})\tau_2 - \tau_1 - \frac{\frac{r - \frac{\delta}{N} - \left(\kappa - \frac{\delta}{N}\right)A}{r}\theta_1 - \psi}{1 - \frac{\delta}{N} - \left(\kappa - \frac{\delta}{N}\right)A} & \text{if } A > \hat{A}_1(N; \theta_1 \delta). \end{cases} \tag{36}$$

The equilibrium condition in state $z = 1$ when the borrower is a speculator is:

$$
\begin{aligned}
I_{\theta_1}(\theta_1^*, \ell, \mu_\ell; N, \delta) \quad \equiv \quad & (\beta - \alpha - 2\overline{\gamma}(\ell; N, \delta))\tau_2 - \tau_1 \\
& + \int_{\frac{\theta_1^* - 1 + \frac{\delta}{N}\left(1 - \frac{\theta_1^*}{r}\right)}{\left(\kappa - \frac{\delta}{N}\right)(\theta_1^* - r)} r}^{1} \left(1 - \frac{\frac{r - \frac{\delta}{N} - \left(\kappa - \frac{\delta}{N}\right)A}{r}\theta_1^* - \psi}{1 - \frac{\delta}{N} - \left(\kappa - \frac{\delta}{N}\right)A}\right) dA = 0.
\end{aligned} \tag{37}
$$

**State $z = 2$: Borrower is not a speculator.** Since the stablecoin borrower does not demand conversion at $t = 1$ independent of the fundamental realization, the threshold $\hat{A}_2(N; \theta_2, \delta)$ is higher than $\hat{A}_1(N; \theta_1, \delta)$:

$$
\hat{A}_2(N; \theta, \delta) \equiv \frac{\theta_2 - 1}{\left(\kappa - \frac{\delta}{N}\right)(\theta_2 - r)} r > \hat{A}_1(N; \theta_1, \delta) \tag{38}
$$

and the indifference condition is now given by:

$$
\Delta_{i,2}(A; \theta_2, N, \delta) = \begin{cases} (\beta_{g_i} - \alpha_{g_i})\tau_2 - \tau_1 & \text{if } A \leq \hat{A}_2(N; \theta_2, \delta) \\ 1 + (\beta_{g_i} - \alpha_{g_i})\tau_2 - \tau_1 - \frac{\frac{r - \left(\kappa - \frac{\delta}{N}\right)A}{r}\theta_2 - \psi}{1 - \left(\kappa - \frac{\delta}{N}\right)A} & \text{if } A > \hat{A}_2(N; \theta_2, \delta). \end{cases} \tag{39}
$$

The equilibrium condition in state $z = 1$ when the borrower is a speculator is:

$$
\begin{aligned}
I_{\theta_2}(\theta_2^*, \ell, \mu_\ell; N, \delta) \quad \equiv \quad & (\beta - \alpha - 2\overline{\gamma}(\ell; N, \delta))\tau_2 - \tau_1 \\
& + \int_{\frac{\theta_2^* - 1}{\left(\kappa - \frac{\delta}{N}\right)(\theta_2^* - r)} r}^{1} \left(1 - \frac{\frac{r - \left(\kappa - \frac{\delta}{N}\right)A}{r}\theta_2^* - \psi}{1 - \left(\kappa - \frac{\delta}{N}\right)A}\right) dA = 0.
\end{aligned} \tag{40}
$$

Note that for a given $N$ the equilibrium conditions in (37) and (40) diverge if $\delta$ increases and they converge to Equation (12) in the limit if $\delta \searrow 0$.

### A.7.2 The stablecoin lending game at $t = 0$

For $\sigma \searrow 0$ the differential payoff of coin holder $i$ belonging to group $g_i$ from participating in stablecoin lending instead of abstaining from it is:

$$
\begin{aligned}
\Delta_i^\ell(\theta_1^*, \theta_2^*; \gamma_{g_i}, r_\ell) \quad \equiv \quad & q\left( \int_{\underline{\theta}}^{\theta_1^*} \left((\kappa + r_\ell)\frac{\frac{r-\kappa}{r}\theta_1 - \psi}{1-\kappa} - \kappa(1 - \tau_1 - \alpha_{g_i}\tau_2)\right) d\theta + \int_{\theta_1^*}^{\overline{\theta}} r_\ell d\theta \right) \\
& + (1-q)\left( \int_{\underline{\theta}}^{\theta_2^*} \left((\kappa + r_\ell)\frac{\frac{r-\kappa+\frac{\delta}{N}}{r}\theta_2 - \psi}{1-\kappa+\frac{\delta}{N}} - \kappa(1 - \tau_1 - \alpha_{g_i}\tau_2)\right) d\theta + \int_{\theta_2^*}^{\overline{\theta}} r_\ell d\theta \right)
\end{aligned} \tag{41}
$$

Note that $d\Delta_i^\ell(\theta^*; \gamma_{g_i}, r_\ell)/d\gamma_{g_i} > 0$, meaning that coin holders belonging to a group with a higher probability of being matched with a seller who has a preference for coin payments do have a higher benefit from lending. Intuitively, they benefit less from the option to demand conversion to cash at $t=1$, because it is more likely that they have to convert back to stablecoins at $t=2$. Moreover, $d\theta^*_{1,2}/dr_\ell = 0$ and $d\Delta^\ell_i(\theta^*;\gamma_{g_i}, r_\ell)/dr_\ell > 0$.

The borrower optimally makes a take-it-or-leave-it offer that allows her to borrow $\delta$ coins at the lowest possible cost by optimally calibrating $r_\ell$ such that just enough stablecoin holders are willing to participate. Hence, the stablecoin lending equilibrium conditions are given by $\Delta^\ell_i(\theta^*_1,\theta^*_2;\gamma_\ell,r_\ell)=0$ and Equation (34), which can be solved for the two unknowns $r_\ell$ and $\ell$.

### A.7.3 The modified stablecoins adoption game at $t=0$

For $\sigma \searrow 0$ the modified differential payoff from adoption of consumer $i$ belonging to group $g_i \in [s,\ell]$ is:

$$\begin{aligned}
\Delta^0_i(\theta^*_1,\theta^*_2;\gamma_{g_i}) \quad \equiv \quad & -(1+r_d-\alpha_{g_i}\tau_2)(\overline{\theta}-\underline{\theta}) \\
& +q\left(\int_{\underline{\theta}}^{\theta^*_1}\left(\kappa(1-\tau_1-\alpha_{g_i}\tau_2)+(1-\kappa)\left(\frac{\frac{r-\kappa}{r}\theta-\psi}{1-\kappa}-\beta_{g_i}\tau_2\right)\right)d\theta+\int_{\theta^*_1}^{\overline{\theta}}(1-\beta_{g_i}\tau_2)d\theta\right) \\
& +(1-q)\left(\int_{\underline{\theta}}^{\theta^*_2}\left(\kappa(1-\tau_1-\alpha_{g_i}\tau_2)+(1-\kappa)\left(\frac{\frac{r-\kappa+\frac{\delta}{N}}{r}\theta-\psi}{1-\kappa+\frac{\delta}{N}}-\beta_{g_i}\tau_2\right)\right)d\theta+\int_{\theta^*_2}^{\overline{\theta}}(1-\beta_{g_i}\tau_2)d\theta\right).
\end{aligned} \tag{42}$$

The solution to the adoption game solves $\Delta^0_i(\theta^*_1,\theta^*_2;\tilde{\gamma})=0$, where $\tilde{\gamma}\in[\gamma_1,\gamma_\ell]$. First, observe that for $q\searrow 0$ stablecoin lending promotes adoption by increasing $\Delta^0_i$. Second, observe that from the analysis of the stablecoin lending game $\Delta^0_i(\theta^*_1,\theta^*_2;\gamma_\ell)>0$ if $\ell\geq s$, which is the relevant scenario. An important insight is that $\Delta^0_i$ is independent of $\ell$ and of $r_\ell$ for $\ell > s$.

If the sparse distribution of groups results in no group having the threshold type $\tilde{\gamma}$, then the marginal group $s^*$, the adoption rate $N^*$, and $\mu^*_s$ are given by:

$$\begin{aligned}
s^*(\tilde{\gamma}) &= \arg\min_g g\mathbb{1}_{\gamma_g>\tilde{\gamma}} \text{ if } \nexists g \text{ s.t. } \gamma_g=\tilde{\gamma} \\
\mu^*_s &= 0 \\
N^*(s^*,\mu^*_s) &= \Sigma^G_{g=s} m_g.
\end{aligned}$$

Instead, if there exists a group $s$ such that $\gamma_s=\tilde{\gamma}$, where $\mu^*_s\in[0,1]$, then:

$$\begin{aligned}
s^*(\tilde{\gamma}) &= \arg\min_g g\mathbb{1}_{\gamma_g\geq\tilde{\gamma}^*} \text{ if } \exists g \text{ s.t. } \gamma_g=\tilde{\gamma} \\
N^*(s^*,\mu^*_s) &= \Sigma^G_{g=s+1} m_g+\mu_s m_s.
\end{aligned}$$

Observe that the fixed size of the stablecoin lending market effectively means that $r^*_\ell$ is determined autonomously by $\Delta^\ell_i(\theta^*_1,\theta^*_2;\gamma_\ell,r_\ell)=0$, because $I_{\theta_1}(\theta^*_1,\ell,\mu_\ell;N,\delta)=0$ and $I_{\theta_2}(\theta^*_2,\ell,\mu_\ell;N,\delta)=0$ only depend on $\delta$ (both, directly and indirectly via $\ell$ and $\mu_\ell$) and not on $r_\ell$. Similarly, $\Delta^0_i(\theta^*_1,\theta^*_2;\tilde{\gamma})=0$ does not depend on $r_\ell$, but only on $\delta$ (directly). I will use this insight in the comparative statics analysis of Proposition 9.

### A.8 Extension with Network Effects

In the version of the model with an adoption externality, the adoption rate not only affects the fundamental equilibrium threshold in the continuation game at time 1, but also directly the payoffs of the conversion game via the payment type probabilities. Restricting attention to out-of-equilibrium beliefs that are consistent with coin holders behaving optimally at time 1 for any observed $N$, I next show that multiple solutions to the two-stage game may co-exist. To see this, consider the special case with one type of stablecoin holder, i.e. $s = G$. Here co-existence emerges whenever there exists an adoption rate $\hat{N} \in (0, m_G)$ such that $\Delta_{0,i}(\theta^*(\overline{\gamma}(\hat{N})), \gamma_G) = 0$ holds with equality, where $\theta^*$ solves Equation (12) for $s = G$ and $\overline{\gamma}(\hat{N})$. There is one solution where all consumer in group $G$ adopt stablecoins ($N^* = m_G$), one solution with no stablecoin adoption ($N^* = 0$) and one solution where some consumer in group $G$ adopt stablecoins ($N^* = \hat{N}$). Similarly, with heterogeneous stablecoin holders there can be multiple values of $s$ such that $\Delta_{0,i}(\theta^*; \gamma_{g_i}) = 0$ holds when evaluated at $\gamma_s$, while it is violated when evaluated at $\gamma_{s-1}$.

At the presence of positive network effects associated with stablecoin adoption, multiple equilibria with different adoption levels can emerge. Nevertheless, the continuation equilibrium is unique for a given level of adoption. Coordination games with strategic complementarities and information acquisition share this feature (Hellwig and Veldkamp, 2009; Ahnert and Bertsch, 2022). Since a higher adoption rate is associated with a lower probability of runs if $d[\beta(1-N) - \alpha(N) - 2\overline{\gamma}]/dN < 0$, more favorable beliefs about stability can be self-fulfilling – they induce a higher adoption rate that turns out to be consistent with higher stability. This multiplicity can be a concern for policymakers, as sudden shifts in adoption can have significant stability implications that may reverberate in financial markets, due to the role of stablecoins as a link between the crypto universe and traditional financial markets (Barthelemy et al. 2021; Kim 2022).