

Case Study #3: The Terra Luna crash: was it a ticking time bomb?

*"My dearest creation named after my greatest invention."
-Do Kwon on naming his newborn daughter Luna, April 2022*

Terra (UST) collapsed in May 2022, erasing \$50 billion in valuation from what had been the world's fourth largest stablecoin, and spreading pain across the crypto ecosystem. The purpose of this study is to understand what factors led to this collapse – was it inevitable? – and what lessons we should take from this event for crypto investors and regulation.

1. Terra's meteoric rise

Terraform Labs created the Terra network in 2018, led by Terraform's CEO Kwon Do-Hyung (known widely as Do Kwon). It was designed as an open-source platform to offer support to developers to build decentralized finance (DeFi) projects. It had two main asset offerings: Terra USD (UST), a so-called "stablecoin" pegged to the US dollar, and LUNA, the native token on Terra's proof-of-stake blockchain.¹

The creators of Terra aimed to create a thriving decentralized ecosystem of financial applications, with real-world payment integrations. Core to this strategy was UST, an alternative to Bitcoin and its extreme price volatility. As outlined in the Terra Whitepaper (Kereiakes et al. 2019), unlike Bitcoin's inflexible supply, "a cryptocurrency [UST] with an elastic monetary policy would maintain a stable price...making it viable for use in everyday transactions."² This "elastic monetary policy" was based on a two-coin system governed by an algorithmic pegging mechanism that relied on the forces of arbitrage (see Box 1 for details).³

Box 1: How did the pegging mechanism behind UST and LUNA work?

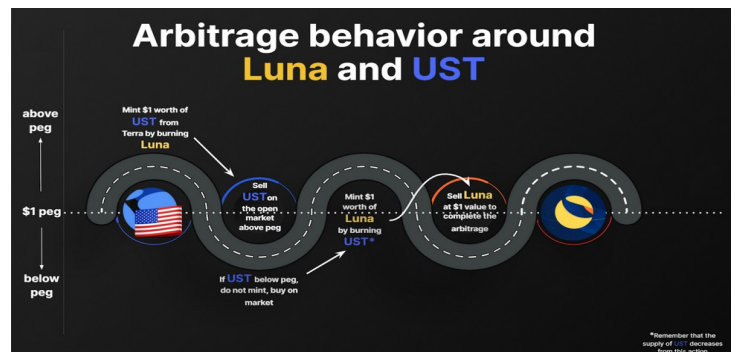
Terra USD (UST) and LUNA were part of the Terra network, which was a platform to support the development of decentralized financial applications, including borrowing, saving, and trading (Liu, *et al.* 2023). UST was a "stablecoin" pegged to the US dollar and LUNA was the native token on the Terra network.

UST's pegging mechanism was governed by an algorithm that worked to achieve stable value for UST by allowing users to create \$1 of UST stablecoins by burning \$1 of Luna and burn \$1 of UST to receive back \$1 of Luna. The forces of arbitrage were supposed to reinforce the peg:

- If $UST < \$1$, arbitrageurs could buy 1 UST, burn it and mint \$1 worth of LUNA, and then sell that LUNA to earn a profit;
- If $UST > \$1$, arbitrageurs could buy \$1 worth of LUNA, burn it and mint 1 UST, and then sell that UST to earn a profit

LUNA's intrinsic value was related to its potential uses: as a staking token in governance votes (the Terra blockchain was proof-of-stake), paying fees for confirming blockchain transactions and generating yields on DeFi lending protocols. It was, however, also reliant on continued UST demand.

In 2022, promoters acquired a \$3.5B in BTC as a backup source of funds to support the system if it came under pressure.

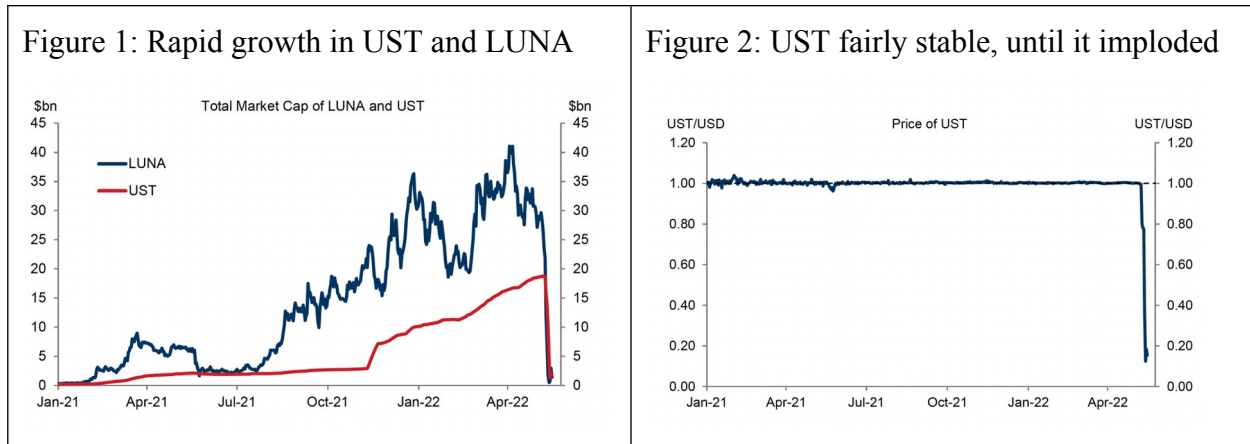


¹ This original LUNA is now known as LUNA classic (LUNC).

² This argument rests on a reasonable view that volatility in bitcoin's price is due to inflexible supply in the face of quite volatile demand.

³ The paper also outlines how incentives, or "efficient fiscal policy," would be used to promote development of decentralized applications on the Terra network.

The Terra network grew rapidly in terms of the value of its native assets and the use of protocols deployed on the Terra blockchain, riding the wave of overall growth in crypto markets in 2021. The total market capitalization of LUNA and UST grew dramatically in 2021 until May of 2022, reaching over \$50 billion at its peak (Figure 1).



Source: Rai (2022)

Some of this success can be attributed to a genuine demand for UST because of a desire to hold value in a decentralized system (without traditional gatekeepers). Along with this, in the months before the collapse, the Terra network had around 73 projects built in the ecosystem and was planning on onboarding many more (Vaca 2022). The total value locked (TVL) in the Terra network reach around \$28 billion just before the crash, seemingly signaling continued faith in the platform.⁴

A protocol called “Anchor,” launched in early 2021, was clearly the most popular project on the Terra network. This protocol greatly boosted incentives to hold UST offering 19.5% interest on UST deposits. At its peak, of the some \$18 billion of UST in circulation, as much as 72% was held at Anchor (Lopatto 2022). The sustainability of this strategy was questionable from the outset, given Anchor wasn’t generating enough income to pay the 19.5% interest. That meant it had to dip into its reserves to pay depositors, and even had to replenish this fund to the tune of \$450 million a couple of months before the Terra Luna crash (e.g., Newbery 2022).

It may be that Do Kwon saw some trouble brewing, when in January 2022 he established the Luna Foundation Guard (LFG), a non-profit foundation charged with defending the UST peg. The LFG bought over \$3 billion of Bitcoin, and had plans to eventually get that to \$10 billion.

2. Terra’s spectacular crash

Terra collapsed within three days in May 2022, wiping out the entire valuation of UST and LUNA (Figures 1 and 2). The collapse was centered around Terra’s algorithmic stablecoin, UST (pegged against the dollar) and a run on Anchor deposits (Figure 3).

The first signs of the run appeared on May 7, 2022, when two large addresses withdrew 375 million UST from Anchor (Liu et al. 2023), leading to a sharp drop in the price of UST. Despite

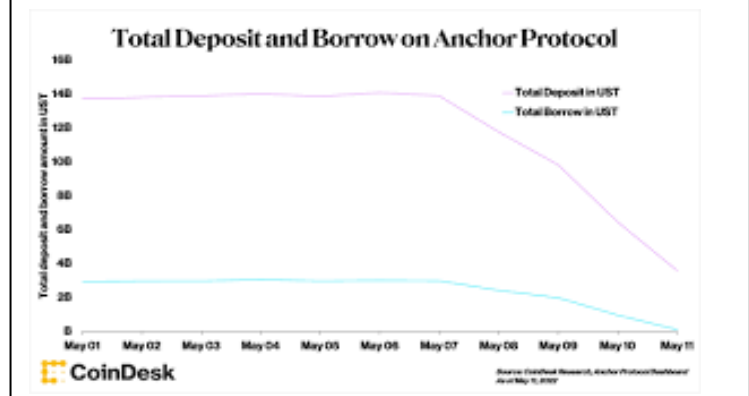
⁴ Total value locked is the US dollar value of digital assets “locked” or staked on particular blockchain network.

attempts by Terraform Labs to stabilize the peg by raising the supply of LUNA (as part of the algorithm) and purchasing UST, investors continued to withdraw their funds from Anchor. By May 9, the market capitalization of LUNA became equal to the outstanding supply of UST.⁵

Given the trigger was a small number of large withdrawals, there were initially accusations of market manipulation by malicious actors exploiting “weakness in the platform’s smart contracts” (Fares 2023). However, careful “forensic” assessment of activity around the time of the collapse using detailed trading data suggests the run on Terra was not due to concentrated market manipulation. Instead it appears to have been precipitated by growing concerns about the sustainability of system (Liu 2023).

The fact that, on May 11, Do Kwon was revealed to be one of the pseudonymous co-founders behind the failed algorithmic stablecoin Basis Cash certainly didn’t assuage concerns. Terra’s founder is currently facing fraud allegations in both South Korea and the U.S. stemming from the Terra Luna collapse (he initially disappeared but is now in Montenegro and court decisions are pending to determine whether he will be extradited to South Korea or the US).⁶

Figure 3: Deposits on Anchor outpaced borrowing



Was Terra doomed from the start?

Probably yes. Many had warned that, by following unsustainable policies, the Terra network was becoming increasingly fragile. This vulnerability came from several self-reinforcing flaws in the design:

- a) The incentives on the algorithm to stabilize UST relied on “normal” conditions whereby there was *trust* that more people would want to buy UST and Luna. We know from history that a system needs to be robust to destabilizing shocks.
- b) The growth model focused on boosting demand for UST (through high interest on deposits on the Anchor platform) using obviously unsustainable means; ever-increasing deposits required ever-increasing subsidies that could only be met through ever-increasing demand for UST and dipping into the reserve fund.
- c) This contributed to serious procyclical dynamics; a rising price of LUNA in the growth phase, since UST was issued by converting LUNA into UST, and a declining price of LUNA in the contraction phase as UST was redeemed in LUNA.

⁵ An earlier de-pegging incident in May 2021 foreshadowed the risks and economic mechanisms that were important during the May 2022 crash. The run was avoided in May 2021, likely due to the smaller outstanding supply of UST in May 2021, which enabled TFL to function as a lender of last resort.

⁶ According to Bloomberg (March 23, 2024), Montenegro’s Supreme Court suspended prior decisions by lower-level courts to extradite Kwon to South Korea.

These design flaws culminated “death spiral” in that, once a few large holders of UST adjusted their positions (withdrawing deposits from Anchor) on May and the stablecoin started to de-peg, the price of LUNA fell. When other investors joined the run as fear replaced trust, this only increased LUNA’s dilution, further depressing its price until it reached 10 cents on May 12.

One could ask whether the Terra network would have survived had they been more patient and developed a steady and sustainable baseline demand for UST. This might have supported the participation of trusting (and thus, willing) arbitrageurs in the network. This was not the case of Terra, whose stablecoin was mainly used to obtain high interest through the Anchor protocol, without any intrinsic worth that would have come from it being used for genuine economic transactions.⁷ The lack of intrinsic worth (i.e., basic usefulness in the real world) not only contributed to the instability of UST, but made it difficult to recover from the crash (Briola et al., 2023).

Did Terra blockchain’s transparency give insiders and sophisticated investors an advantage?

Unlike in a classical Ponzi scheme, the subsidy provided by Terraform Labs was not hidden, it was recorded on the Terra blockchain and, in principle, observable by all investors. However, because of complexity of the system, it is unclear the extent to which unsophisticated investors understood the nature of UST claims and the possible impact of UST conversion on the LUNA price. Moreover, Terra insiders likely contributed to the hype about the network by aggressively underplaying the risks building up in the system on social media and other outlets.

In theory, transparency in blockchain technology with regards to activity and price data should level the playing field in terms of allowing investors to monitor each other's actions; this would be an advantage over traditional finance. In the case of Terra LUNA, it not only amplified the speed of the run it enabled wealthier and more sophisticated investors to run first and therefore experience much smaller losses (Liu et al. 2023). Many medium-sized and smaller investors actually bought into the dip initially, which suggests that larger investors were able to sell their assets to smaller ones before the steep price decline. When they finally did run, they faced larger losses (Liu et al. 2023 and Cornelli et al. 2023).

This highlights the limitation of transparency, especially for complex systems like Terra-Luna. The mingling of sophisticated and unsophisticated investors in the way we have seen in crypto markets (i.e., without restrictions and investor protection provisions) is unusual in traditional finance. As well as teaching us something about the limitations of transparency, the Terra Luna crash may give us lessons on the merits of allowing equal participation of investors, irrespective of size and sophistication. Ultimately, the sustainability of the DeFi ecosystem depends on the ability of investors to make informed decisions and hold projects accountable for their actions.

3. Consequences of galactic proportion in crypto world

The collapse of UST and LUNA sent shock waves throughout the crypto ecosystem given its size and interconnections between different parts of the system. These effects were seen rather quickly in a number of areas including terra-based protocols such as the Anchor Protocol,

⁷ The Anchor protocol was also used to engage in “yield farming” where newly-minted LUNA was used as collateral to borrow UST and then earn interest on the borrowed UST by depositing it in Anchor.

Astroport and Mars Protocol that saw their prices falls as much as 80% in the days following LUNA's decent.

The interconnectedness between centralized exchanges, and sentiment also contributed to price and liquidity spillovers in other cryptocurrencies including bitcoin. Terra's BTC and LFG's reserve dumps probably added sell-pressure to an already tumultuous market.

This event marked the first significant run in crypto and triggered a chain reaction that led to the collapse of several other prominent players, including Celsius and Three Arrows. As discussed above, the crash also resulted in many retail investors losing their life savings.

While the Terra Luna collapse had clear negative spillovers to the broader crypto ecosystem, it did not induce financial stress in the traditional financial system. For instance, drops or gains in active users in crypto exchanges and traditional equity prices or financial conditions indices during the collapse period for both Terra and FTX (Figure 4). This supports a general consensus among international authorities that stablecoins do not pose systemic risks at this stage, but they may pose risks if significant growth continues to occur.

4. Stablecoin in name only

These events also demonstrated the need for robust regulation for stablecoins to ensure that, if they are to be used for payments, they can maintain a stable value, and that coin holders can redeem the entirety of their money at par at all times. While UST was obviously unstable by design, it is still unclear whether *any* algorithmic stablecoin could be inherently stable.

In an article published by Coindesk just days after the collapse, the authors wrote "Don't be surprised when the regulators come knocking," (Kessler et al. 2022).

The regulators have come knocking, although progress is slow. In the UK, no stablecoin that is (or is expected to be) systemically important can be algorithmic, and the Bank of England is consulting on a proposal that the only acceptable backing asset would be central bank reserves.

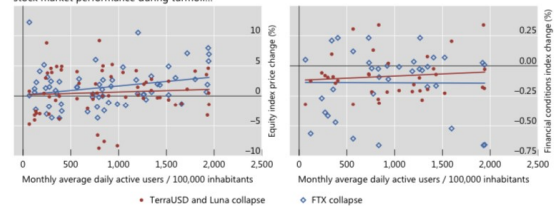
In the US, the ***Clarity for Payment Stablecoins Act***, which seeks to bring stablecoins within the same regulatory frameworks that govern traditional financial services companies, was passed by the House Financial Services Committee in 2023. It has moved to the floor of the House of Representatives for consideration, but has yet to be approved lawmakers in the House. The Act outlines requirements such as how stable coins are backed (e.g., at least one-to-one with high quality liquid assets), custodial obligations (e.g., no comingling of customer and custodian's own funds) and a 2-year moratorium on endogenously-collateralized (algorithmic) stablecoins (Scott 2023).

Finally, central banks and other authorities charged with financial stability have a relatively sophisticated, albeit imperfect, framework for assessing systemic risk in the traditional financial system have, this is far from the case when it comes to the crypto ecosystem. How risks build up

Figure 4: No signs of contagion to TradFi

Crypto turmoil had little effect on the broader financial system Graph 3

A. No strong relationship between crypto adoption and stock market performance during turmoil... B. ...or with financial conditions



The variable on the x-axis corresponds to the country-specific maximum value of the crypto exchange apps' monthly average daily active users per 100,000 inhabitants over the period Jan 2021–Jun 2022. The variables on the y-axis correspond to the seven-day percentage change from a crash episode in the MSCI country-specific local currency price index for panel A, and the country-specific financial conditions index (FCI) for panel B. Data are winsorised at the 5th and 95th percentiles.

Sources: Bloomberg; Refinitiv Eikon; Sensor Tower; authors' calculations.

Source: BIS (2023)

and is propagated in adverse shocks in DeFi, where contracts are programmed to undertake actions, is not well understood. At a minimum, we need more data and more research from the DeFi industry on the systemic implications of protocol design (e.g., the extent to auto-liquidation can be procyclical as was the case with Terra Luna).

Questions for discussion:

- a) *What did Terra-Luna have going for it that led to such rapid growth?*
- b) *Was Terra-Luna a Ponzi scheme in the Terra network, and why or why not?*
- c) *To what extent could algorithmic stablecoins ever be stable, and why?*
- d) *Why were investors late to realise the problem with Terra Luna?*
- e) *What regulations and supervision should be considered?*
- a) *Is transparency of the blockchain a source of instability and risk?*

References

- Bank of England, "Regulatory regime for systemic payment systems using stablecoins and related service providers," Discussion Paper, November 6, 2023. <https://www.bankofengland.co.uk/paper/2023/dp/regulatory-regime-for-systemic-payment-systems-using-stablecoins-and-related-service-providers>
- Briola, A., Vidal-Tomás, D., Wang, Y., Aste, T. (2022). Anatomy of a stablecoin's failure: The Terra-Luna case. Finance Research Letters, doi: <https://doi.org/10.1016/j.frl.2022.103358>
- Fares, Rudy, "The Man behind Terra Luna Do Kwon is Finally Jailed: Why did Terra Crash?" Cryptoticker, June 20, 2023 <https://cryptoticker.io/en/terra-luna-do-kwon-in-jail-why-did-terra-crash/>
- Kate. "Crypto Contagion: How Does It Work, And Why Should You Care," February 25, 2024, <https://www.liquidloans.io/vault/research/tradfi/crypto-contagion>
- Kereilakes, Evan, Kwon, Do, Di Maggio, Marco and Nicholas Platias, "Terra Money: Stability and Adoption," April 2019, <https://whitepaper.io/document/587/terra-whitepaper>
- Kessler, Sam, Young, Sage D., "The LUNA and UST Crash Explained in 5 Charts," Coindesk, May 11, 2022 <https://www.coindesk.com/layer2/2022/05/11/the-luna-and-ust-crash-explained-in-5-charts/>
- Liu, Makarov and Schoar, "Anatomy of a run: the Terra Luna Crash," 2023 NBER WP 31160.
- Lopatto, Elizabeth, "How the Anchor protocol helped sink Terra," The Verge, May 20, 2022. <https://www.theverge.com/2022/5/20/23131647/terra-luna-do-kwon-stablecoin-anchor>
- Newbery, Emma, "Here's Why I'm Passing on Anchor's 20% APY," the ascent, April 19, 2022 <https://www.fool.com/the-ascent/cryptocurrency/articles/heres-why-im-passing-on-anchors-20-apy/>
- Scott, Andrew P., Tierno, Paul, "An Overview of H.R. 4766, Clarity for Payment Stablecoins Act," Congressional Research Service, September 25, 2023 <https://crsreports.congress.gov/product/pdf/IN/IN12249>
- Vaca, Inigo, "Collapse of Terra blockchain ecosystem forces talent migration," Cointelegraph, September 13, 2022 <https://cointelegraph.com/news/collapse-of-terra-blockchain-ecosystem-forces-talent-migration>
- Wong, "Why Stablecoins Fail: An Economist's Post-Mortem on Terra," Federal Reserve Bank of Richmond, July 2022