Terra’s LUNA 2022 Investigation Report

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Decentralized Finance and Smart Contract Programming Course

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Introduction to stablecoin

For many years cryptocurrencies have been starting to influence our lives. Everybody around the world is more aware of cryptocurrencies than ever before, one of the many concepts that are widely used in this digital world is stablecoin. Stablecoin is a type of cryptocurrency that has certain mechanics to maintain its value, for instance, peg the value of its currency to external sources like the USD, other world currency, or even gold price. Peg in this case according to ALEXANDRIA CoinMarketCorp, is a specified price for the rate of exchange between two assets. [1] As the name implies stablecoin aim to preserve its value over the years by tied with fiat, commodity, or financial instruments. It aims to remain purchasing power which fiat cannot. With this goal, stablecoin could be an alternative medium for exchange than fiat or high volatility cryptocurrency. Unlike other currencies like Ethereum which has a high price fluctuations rate. Thus the stablecoin has properties similar to real money that is, the property of store of value as in Investopedia; an asset, commodity, or currency that maintains its value without depreciating. [2] In other words, an asset, commodity, or currency that can use in transactions in which over time, the value must be worth equal to the present or more. The other property is the unit of account as in Merriam-Webster; a monetary unit or measure of value in terms of which accounts are kept and values stated. [3] With these properties analogous to real money it is often used as a means of transaction.

There are multiple types of stablecoin which can be categorized as follows:

Fiat-collateralized; stablecoin that is backed by Fiat currency, in which the issuer of stablecoin will reserve real money currencies (USD, Euro, Pound, etc.) to a certain third party custodian to be kept as collateral and audited. The popular examples of fiat-collateralized stablecoins are Tether (USDT), USD Coin (USDC), Paxos Standard (PAX), TrueUSD (TUSD), Gemini Dollar (GUSD), etc.

Commodity-collateralized; stablecoin that is backed by any type of interchangeable assets for instance gold is one of the most common assets, but other assets can be stocks, oil, fund, land, etc. Just like fiat-collateralized, this stablecoin must also have a central authority or third party that is in charge of producing and releasing the coin. Many of the popular commodity-collateralized stablecoin are Tether Gold (XAUT), Paxos Gold (PAXG), Digix Gold (DGX), Tiberius Coin (TCX), etc.

Crypto-collateralized; stablecoin that is backed by other cryptocurrencies. Unlike the other two mentioned before, this stablecoin does not need any central authorities or third parties to produce which means it is decentralized. The decentralized element of this coin makes it highly trustworthy in itself. To create this coin; cryptocurrencies that have considerably more value than the stablecoin itself are to be collateralized, in other words, over-collateralization. Since cryptocurrencies tend to have a lot of price fluctuation, if the price of said currencies decreased significantly enough, the stablecoin will then be liquidated automatically. The popular

crypto-collateralized stable includes but is not limited to MakerDAO (Dai), EOSDT Token, Origin Dollar (OUSD), and mStable (mUSD).
Non-collateralized; stablecoin that is backed by nothing. This type of coin is quite similar to real-world money the most. The value of this coin is controlled by the algorithm. When the demand increases, new coins are produced with the intention of bringing down the price to the usual measure. On the other hand, if there are low trading activities, coins will be brought up to lessen the circulation supply. In other words, this stablecoin is dependent on supply and demand. It can use the algorithms to maintain its balance or peg so it does not need any collateral to back it up. The popular examples of this type of stablecoin are Ampleforth (AMPL), Basis, etc.

All in all, these stablecoins open many more opportunity in finance for the people, as some countries' currency depreciate day by day people have the ability to use stablecoin which mean people do not have to be dependent on any one currency but instead worldwide accepted currencies. However, there are still some problems in using stablecoin. For instance law-related problems, stablecoin still has a long way before being accepted in a wide society without any government intervention, since stablecoin is out of government control it might be a potential competitor to the real currencies and is still only being used in the cryptonomic system almost exclusively. This means it is still not accepted to be used locally like in the convenience store and such.

TerraUSD classification and its mechanics for maintaining the peg to USD

Stablecoins have a part as an essential role in the cryptocurrency economy as stated in the previous section, there are many stablecoins in the system and TerraUSD is one of the big popular choices for investors out there to make money.

TerraUSD or UST is a decentralized stablecoin that is operating on the Terra blockchain protocol produced by Terraform Labs in 2018 founded by Do Kwon and Daniel Shin. Figure 1 is the chart for TerraUSD as of writing this report. According to this article written in 2021 [4], it was the fourth-largest stablecoin with a market cap of 7.223 billion USD recorded in CoinMarketCap, the cryptocurrency website that provides market cap rankings, price charts, and more. The International Token Standardization Association [5] has provided the classification from the International Token Classification (ITC) token database as shown in Figure 2 which consists of the full detailed classification of TerraUSD.

Figure 1: TerraUSD chart from CoinDesk

International Token Classification (ITC) Version 1.0	
ECONOMIC PURPOSE (EEP):	EEP21PP01USD: Fiat-Pegged Payment Token > USD-Pegged Payment Token
ISSUER INDUSTRY (EIN):	EIN06PS: Finance and Insurance > Payment Services and Infrastructure
TECHNOLOGICAL SETUP (TTS):	TTS41BC: Ledger-Native Token > Blockchain-Native Token
LEGAL CLAIM (LLC):	LLC31: No-Claim Token
ISSUER TYPE (LIT):	LIT62DL: Entity without Legal Personality > Distributed Ledger Protocol
REGULATORY STATUS (EU) (REU):	REU52: Crypto Asset out of Scope of MiCA

Figure 2: The TerraUSD ITC classification entry
Source: Adapted from [5]

It can be seen from Figure 2 that TerraUSD is categorized as a USD-pegged payment token which the article claims that it is similar to other stablecoins in the industry. The industry type for TerraUSD is in the field of Payment Services and Infrastructure and is listed as Ledger Native Token. The issuer type for TerraUSD as a coin is an Entity without Legal Personality and according to the European Commission, TerraUSD is qualified as Crypto Asset out of the Scope of Markets in Crypto Assets (MiCA).

To quote from the Terra protocol documentation [6], Terra protocol is the leading decentralized and open-source public blockchain protocol for algorithmic stablecoins. The main feature that differentiates Terra from other cryptocurrencies is that it pegs the cryptocurrency to an existing fiat currency. It has several stablecoins to track different fiat-currencies such as KRT for the South Korean Won and EUT for Euro. As for TerraUSD, it tracks the price of 1 USD and tries to maintain the price ratio between TerraUSD and USD to 1:1 as much as possible. For the algorithm to be successful, Terra uses Luna, a native staking token to help in the protocol. It would be better to explain the workings and mechanics of the protocol after the initial information about the Luna token.

The roles of the LUNA token and the Anchor protocol

According to the previous section, Luna token is very essential to the Terra protocol to maintain the peg and stabilized the TerraUSD. Luna is a native staking token that can be used to stake the token to the network in exchange for rewards from the transaction fees. Figure 3 is an example provided by the Youtube video from decryptoverse [7] If the user stakes an amount of 100 Luna tokens to Terra network, the user will receive 8 percent APR, an annual percentage rate which translates to 8 Luna tokens after 1 year. With promised rewards, people will be convinced to make more transactions which will then push the price of Luna tokens up.

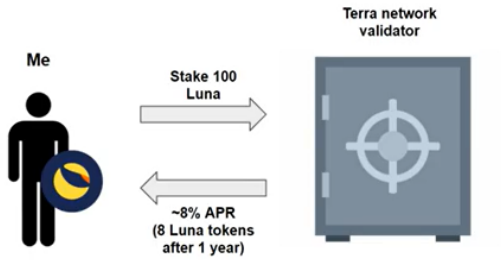

Figure 3: Example use case of Luna as stake token
Source: Adapted from [7]

Luna tokens can also be used as governance tokens to cast a vote on proposals that affect the change on the network. As seen in Figure 4, the user who holds Luna token will be granted a voting power to propose that no tax will be collected for stablecoin transfer and thus has an influence on the Terra protocol.

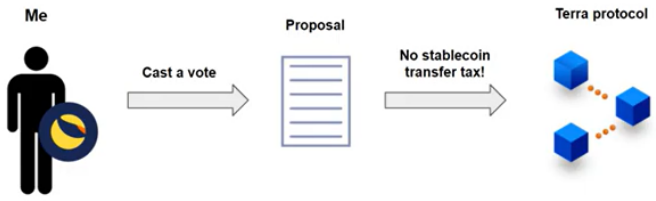

Figure 4: Example use case of Luna as a governance token
Source: Adapted from [7]

The role of Luna token in maintaining the peg of TerraUSD to USD is to be used to manipulate the TerraUSD price. If the price exceeds 1 USD, that means the supply of TerraUSD has gone down and demand is too high. The protocol then incentivizes users to burn or, as explained in Figure 3, stakes Luna tokens which will reduce the amount of Luna pool and increase the supply of TerraUSD pool from the TerraUSD minting in the process. After balancing the demand and supply, eventually, the price will do down to 1 USD.

On the other hand, when the TerraUSD price is lower than 1 USD that means the demand for TerraUSD is low and the supply is too many. The protocol will do the opposite of the previous issue and incentivizes users to burn TerraUSD and mint Luna which will results in more TerraUSD supply in the network, less demand, and the price will go up again. Other than used for payments, Terra can be used to build applications for lending, borrowing, insurance, and charitable causes as well. The CoinDesk website [8] has provided lists of several decentralized applications built with Terra blockchains such as Anchor, Chai, and Mirror. In this section, we will be focused on Anchor or Anchor protocol.

The official documentation of Achor [9] stated that Anchor is a decentralized lending protocol that offers low-volatile yields on Terra stablecoin deposits. Since released in March 2021, Anchor has become the largest decentralized application on Terra blockchain by total value locked with over 8 billion cryptocurrencies deposited into the savings protocol. It gains its fame from offering one of the highest yield rates in the industry. In Achor protocol, there are lenders who deposit TerraUSD to earn yields on their stablecoins and borrowers who take out loans from those deposits and pay interest rates which will become those yields for the lenders and the cycle continues. According to the article from ITSA [5], There can be trends of the system having lenders more than borrowers, and with how big the scale of TerraUSD proportion in the Terra ecosystem, critics see the Achor Protocol as a potential risk to the ecosystem as it has happened in July 2021 when Terra protocol injected 70,000,000 USD worth of TerraUSD into Anchor Protocol because it was at risk of running out of funds. Although the Terra protocol seems efficient and provides high profits for users, there are still weaknesses in the mechanics itself that will be addressed in the next section.

Weaknesses in the mechanics that can cause TerraUSD to depeg

The reason that causes TerraUSD to depeg is according to its mechanic, which differs from other stablecoins because TerraUSD has no reserves. Other stablecoins, the Asset-backed Stablecoins, are backed by some assets, such as gold, oil, other cryptocurrencies, or even real estate. For example, the USD Coin that is backed by the U.S. dollar means its value will not least than a USD. On the other hand, TerraUSD, Algorithmic Stablecoin, mechanics, is to use its algorithms to maintain its price. If the price decrease significantly, the algorithm prevents miners from minting too many tokens to increase the price and vice versa in the case the price rises too high.

Figure: Algorithmic of TerraUSD and Luna
Source: Adapted from [15]

To be more specific [10], TerraUSD balances this algorithm in tandem with another cryptocurrency token from the same blockchain network, Luna. Both cryptocurrency prices depend on the market demand, but they are free to exchange with each other at the same price–1 TerraUSD always equates to 1 Luna, and 1 Luna always equates to 1 TerraUSD. For the instance, in case you are an investor and have some TerraUSD coins when the price of TerraUSD falls below $1 but Luna is still equating to $1, you will gain some profit from exchanging TerraUSD to Luna at the time, and according to the balancing algorithm, after your exchange, some TerraUSD will be burned away to rises its price, the same process happens when Luna price fall, so after all total value of both cryptocurrencies remains the same.

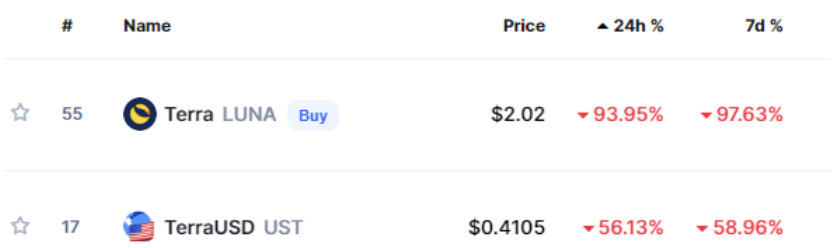

Figure: situation when weakness affected (May 11, 2022)
Source: Adapted from [16]

The balancing algorithm might look stable and reliable, however, there is also a big weakness inside of this logic that is the algorithm can work only when people believe in both TerraUSD and Luna values and its algorithm potential. If something occurs that causes people's fears, and a rising supply of both Terra coins at the same time, the mechanics will tumble.

Stablecoins similar to TerraUSD that possesses the same kind of weaknesses and have failed before

According to the TerraUSD's weaknesses are caused by its mechanic of balancing its price with another cryptocurrency without any reserves and the recent incident that happened to Luna — The breaking of the balancing act between TerraUSD and Luna, even though there is the reset system plan proposed by Terraform Labs, the current situation of TerraUSD and Luna is almost hopeless. As evidenced by the failure of the Basis Cash case [11] and the Empty Set Dollar case that happened in late 2020, both failed to manage and maintain their peg of $1 on the Ethereum network using the similar algorithmic as TerraUSD and Luna.

Basis Cash [12] is the cryptocurrency founded by BitClout (with Terraform Labs behind the scene). It was balancing its price with other cryptocurrencies — Basis Shares and Basis Bond. It was launched in late 2020 and failed in January 2021. People acknowledged this project as a seigniorage-algorithmic testing project of Terraform Labs.

Figure: the 3 cryptocurrencies of Basic Cash protocol
Source: Adapted from [17]

The same goes for Empty Set Dollar. Under [13] a pseudonym, it balanced its price with more centralization risks such as USDC, USDT, AMPL, BASED, and DAI [14]. but also fail within a few months after the establishment.

Details of the attack on TerraUSD and LUNA that causes “the death spiral”

At the current date of writing this report the value of LUNA had decreased by almost 96% in the last 24 hours while TerraUSD had decreased by 33% in the last 7 days. Currently, TerraUSD stablecoin is worth only 0.6 USD instead of 1 USD as it supposes to be. [18] This is a result of a chain of events that happens not long ago.

Earlier this March Do Kwon, CEO of Terraform Labs created the Luna Foundation Guard or LFG which bought 1 billion worth of bitcoin as a reserve to fund and backed TerraUSD value. Unfortunately, due to the current economic situations around the world and the dire situation of the USSR and Ukraine have caused increased inflation in all assets. Investors started to sold of their bitcoin making the price go down significantly. This has reduced the value of bitcoin held by LFG which also impacted the value of TerraUSD. There were also huge short of TerraUSD in the exchange like Binance. Moreover, one of many article websites has been pointing out one of the earliest signs of TerraUSD dropping. Sam Kessler and Sage D. Young touch on the Anchor lending protocol [19] in Terreform Labs. Anchor will give profits potentially up to 20% on the same year that investors deposit their TerraUSD to the platform to attract investors. The problem is that Anchor’s high rate of profit was unsustainable. Terraform Labs could not possibly pay the investors that much for an extended period of time. Sooner or later, they would run out of money while the investors of Anchor disappear. Currently, the deposit of TerraUSD had dropped significantly, since Anchor declare to change the 20% rate to a variable rate so investors

withdraw their possessions onto the open market. This may be a part of the reason for selling pressure on the Terraform Labs. The selling pressure leads to a decrease in LUNA and TerraUSD prices. Until there is no 1 USD worth of LUNA for every 1 USD TerraUSD anymore and caused the investors to panic and sell increasingly.

There are also some theories about the attack on TerraUSD and LUNA. Some people think that there might be an attack by exploiting the TerraUSD. One Twitter user by the name of OnChainWizard guesstimated that the cost of LFG bitcoin is around 42,000 USD per bitcoin [20]. The attacker has around 4.2 billion USD in the short position for bitcoin while also having 1 billion USD in the over-the-counter position in TerraUSD. Before this LFG decided to remove a significant amount from 3pool before creating a new pool called 4pool along with the attacker which also remove a significant amount of TerraUSD from said pool. Since the liquidity on 3pool is already low before 4pool, the attacker can easily drain the pool with only 350 million USD. This causes TerraUSD to fall below 1 USD (approximately 0.9 USD). With that, the attacker goes on to offloading on Binance with their remaining 1 billion USD over-the-counter position. This caused the investors in Anchor to fluster leading to more de-pegging. In order to maintain the peg LFG then start to sell their bitcoin while the attacker was trying to sell their TerraUSD on Binance. Finally, the chain was getting overcrowded and the centralized exchanges stopped all withdrawal activities of TerreUSD temporarily. Leading the bank in trepidation, de-pegging TerraUSD to 0.6 USD. The crypto community was also waiting in agitation to see how much bitcoin will be sold off in order for the peg to be kept. Meanwhile, more LUNA got liquidated because of its mechanism. It is guesstimated that the attacker would make approximately 952 million USD on the short position if they can buy back the position at around 32,000 USD.

Either one of these scenarios or the combination of both leads LUNA and TerraUSD into a death spiral. An excellent example explained by Matt Levine [21] which I understood as the following is that when there is someone that sold TerraUSD, arbitrageurs will buy it for 0.99 USD, then go trade it for 1 USD worth of LUNA. If LUNA is at 40 USD each TerraUSD will be worth 0.025 LUNA. The arbitrageurs will then, sell their 0.025 LUNA onto the market, causing the LUNA price to decrease. Some other people now sold some more TerraUSD for LUNA which is now worth 20 USD. The arbitrageurs will then, sell their 0.05 LUNA onto the market. Thus, the current worth of LUNA is 10 USD so 1 TerraUSD will be worth 0.1 LUNA. Again, some people sold their TerraUSD which cause LUNA to decrease to 5 USD, then 1 TerraUSD will be worth 0.2 LUNA. This can go on and on into a downward spiral since there is no natural stopping point, hence the term death spiral. With the recent chain of events, investors are burning more TerraUSD for LUNA, thus the supply of LUNA shoots up causing the price to reduce. As more investors burn TerraUSD to mint LUNA, the mechanism function comes to a halt. Both TerraUSD and LUNA crashed.

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