COINMETRICS

DEFI'S DOUBLE-EDGED SWORD

Unpacking the Features and Risks of DeFi Lending

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SUMMARY

Decentralized Finance (DeFi) has emerged as a transformative force—building on conventional financial principles and harnessing the unique properties of blockchains to enable a suite of financial services. Underpinned by its inherent transparency, composability and non-custodial nature, we've seen individuals and institutions alike, beginning to embrace it. While DeFi provides several advantages to users, it also opens the door to novel risks. With the increased innovation and access to information for stakeholders involved—hacks, attacks, and exploits have increased in tandem. Therefore, it is paramount to recognize these risks, in order to inform more sound risk-management and strengthen these applications going forward.

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1 INTRODUCTION

The 2022 collapse of FTX—a centralized crypto exchange, has highlighted the promise of Decentralized Finance (DeFi) platforms due to their inherent transparency, composability, and non-custodial nature. We've seen individuals and institutions alike, recognizing the value of DeFi and beginning to embrace it. While DeFi provides several advantages to users, it also opens the door to novel risks. With the increased innovation and access to information for stakeholders involved—hacks, attacks, and exploits have increased accordingly. Therefore, it is paramount to recognize these risks, in order to inform more sound risk-management and strengthen these applications going forward.

Through this report, we'll understand how DeFi lending protocols work, and illuminate risks within these markets through the lens of two recent exploit events. The first recounts a strategy carried out by an individual actor named Avraham Eisenberg, also known as Avi or ponzishorter.eth (ENS name). Eisenberg is infamously recognized for his "highly profitable trading strategies" and most notably, an attack he mounted on Aave v2 in November 2022, which created a fiscal shortfall for the protocol amounting to $1.6 million. We also delve into a recent exploit on the decentralized exchange Curve Finance, examining its spillover effects on the rest of the DeFi lending ecosystem.

We highlight these recent exploit events by exploring account flows and applying a balance sheet-like methodology to contextualize events that unfolded. Additionally, we gauge the implications of such risk events on Aave, and shed light on current fragilities in DeFi lending markets and Decentralized Finance at large. However, before diving in, it'd be useful to set the foundation by understanding the importance of lending in financial markets, how DeFi lending fits in and familiarize ourselves with how these platforms function.

2 LENDING IN TRADITIONAL & DECENTRALIZED FINANCE MARKETS

Lending and credit are crucial components of human society having played an important role throughout the history of financial markets. Fundamentally, the concept of lending entails the act of borrowing something, with the mutual understanding and commitment of repayment. This concept has manifested into several forms, meeting the needs of individuals (student loans, mortgages) and corporations alike. Therefore, lending helps fuel economic growth making it an indispensable function of any economy.

Lending in Traditional Finance Markets

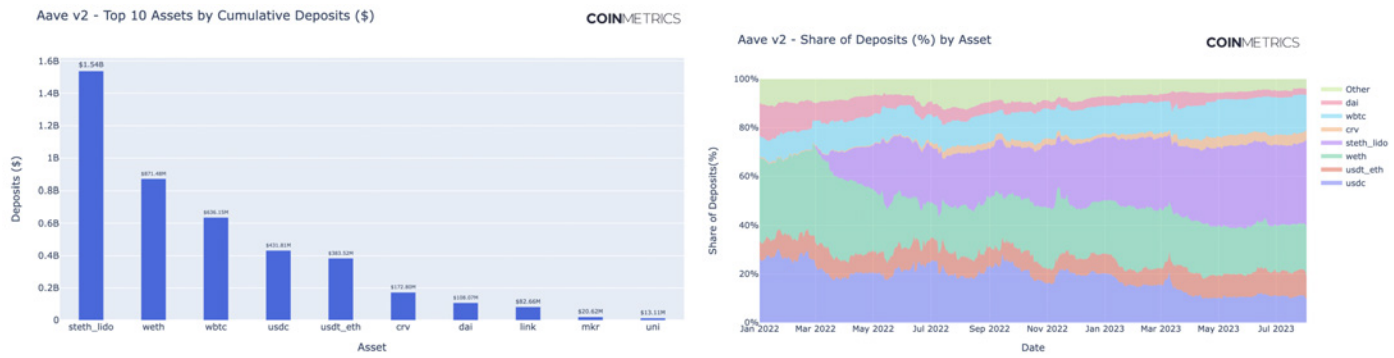
These activities are primarily fulfilled by banks (commercial & central banks) and lending businesses. Central banks and commercial banks facilitate lending activities by increasing their assets (loans receivable) and liabilities (borrower's deposits) on their balance sheets. As 'lenders of last resort'—central banks increase money supply via the issuance of large-scale loans. On the other hand, commercial banks issue loans for industrial purposes, representing their promise to repay the central bank. Lending businesses, in contrast, cannot 'create' money and therefore solely act as intermediaries reliant on obtaining funds from lenders before offering loans. Credit evaluations are central to the operation of these markets and, as a result, they rely on trust and court systems.

Lending in Decentralized Finance Markets

The emergence of blockchain technology has paved the way for decentralized finance (DeFi)—creating an ecosystem of financial services without the need for a central authority or intermediaries. DeFi lending protocols like Aave and Compound serve as an example of this—providing indispensable lending services through automated financial contracts, often referred to as "smart contracts." At its core, they connect users seeking a source of income on their digital asset holdings to those in search of liquidity, forming a decentralized liquidity market. The protocol's utilize a peer-to-pool model, wherein borrowers interact with a collection of smart contracts that "pool" together capital supplied by lenders (ERC-20 tokens). Therefore, operational aspects such as facilitating ample reserves, setting interest rates and maintaining collateral—typically handled via intermediaries are dictated by code in smart contracts. Lending activity in decentralized finance markets can also be reasoned via the lens of a balance sheet, with loans lent by the protocol representing assets and user deposits representing the liabilities for the protocol.

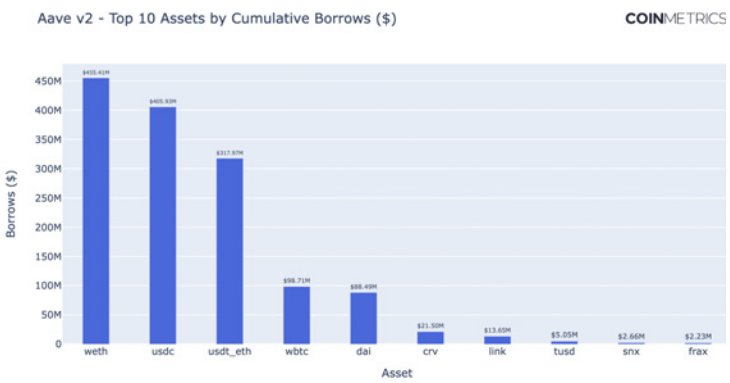
3 HOW DEFI LENDING WORKS

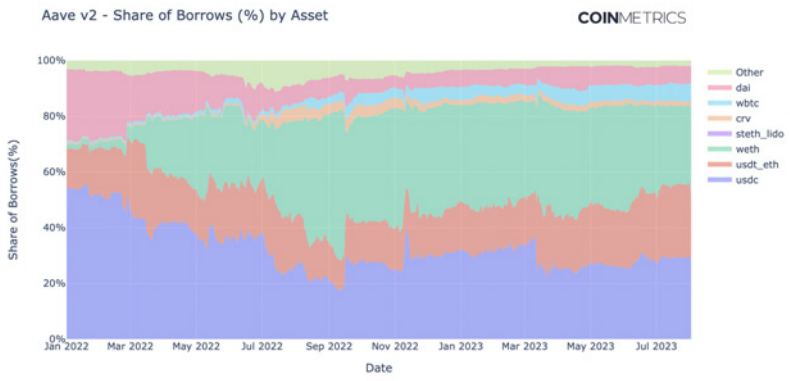
In general, DeFi lending platforms are open-source and non-custodial liquidity venues allowing users to participate as lenders or borrowers. Lenders deposit digital assets into a pool and subsequently receive a receipt on their deposits via an IOU token, which in Aave is called the aToken). Aave's aTokens allow users of the platform to redeem the principal and accrued interest associated with lending and borrowing activity. Put differently, aTokens function as a unit of account within DeFi protocols whereby holders can calculate how much they can borrow in any given market following its Loan-to-Value (LTV) requirements as well as a simple way to disburse interest payments, much like a coupon.



Source: *DeFi Balance Sheets*

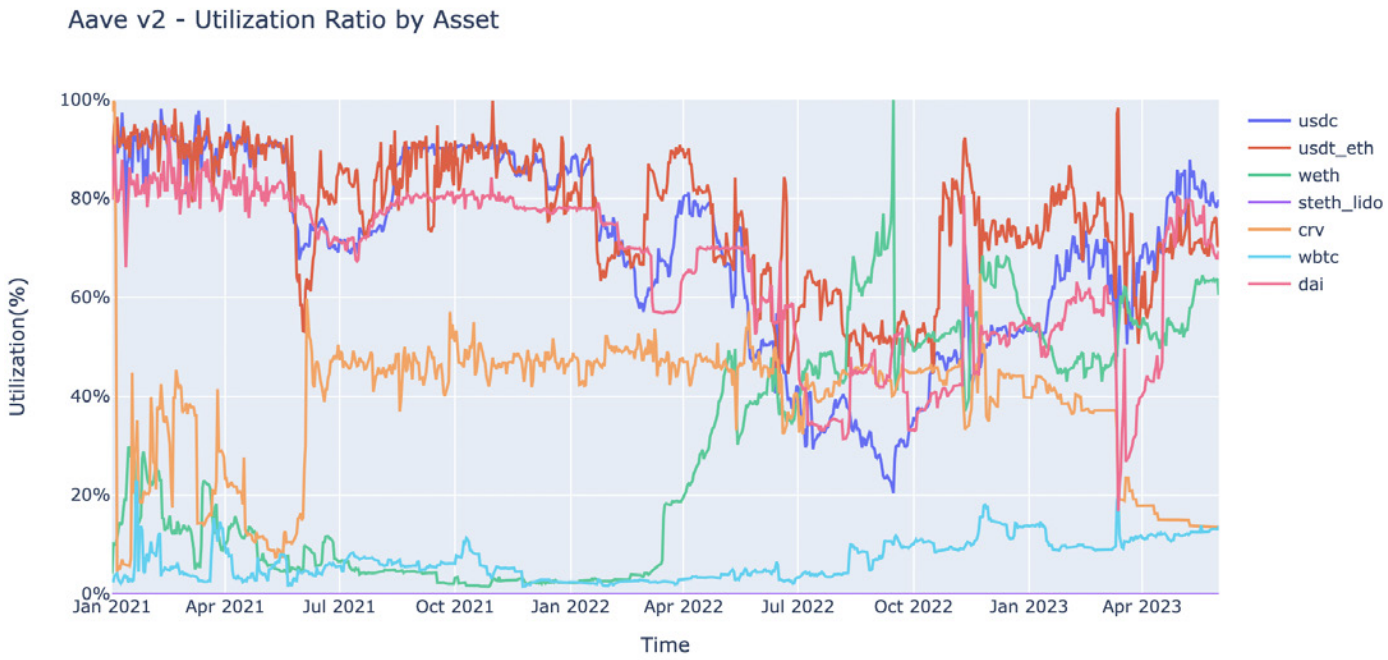
Lenders earn interest on their deposits from borrowers, who can borrow assets supplied in the pool. In decentralized lending protocols such as Aave or Compound, overcollateralization acts as a key risk management tool due to the volatility of crypto-assets and the challenges of determining on-chain creditworthiness. To ensure protection against potential defaults, the protocols stipulate that the value of collateral provided by borrowers must exceed the value of the loan. This provision ensures that, even in highly volatile market conditions, the collateral can be liquidated for a value greater than the loan, adding additional security to lenders.





Source: *DeFi Balance Sheets*

Interest rates for borrowing and depositing act as an incentive mechanism for users, which adjust dynamically based on the utilization rate of a pool (i.e. the percentage of deposited funds that are being borrowed). Utilization, therefore, serves as an indicator of capital availability and helps manage liquidity within pools. Put simply, when a pool has abundant capital available but low demand for borrowing (i.e. low utilization), the interest rate is reduced to attract borrowers. Conversely, when capital within a pool is scarce (i.e. high utilization), interest rates rise to encourage debt repayments and additional deposits. As evidenced below, stablecoins like USDC, USDT & DAI have historically been popular assets to borrow, leading to their reserves being among the most utilized.



Source: *DeFi Balance Sheets*

In the context of DeFi lending markets, risk management is handled through parameters baked into the protocol code. These parameters, such as protocol yields, can be managed by the protocol creators, although in some cases—such as with Aave—they are managed through a governance process. Mirroring traditional finance, the concept of a Loan-to-Value (LTV) ratio is used as a crucial risk parameter, which specifies the maximum borrowing capacity against provided collateral. Taking into account the volatility of crypto-assets, LTVs required by decentralized lending protocols vary widely based on the type of collateral. Therefore, understanding these nuances and playing an active role in the governance process is pivotal for users.

For instance, users can borrow up to 87% of their USDC collateral's value, while more volatile assets like Curve's CRV token have a lower loan-to-value (LTV) ratio of 55%. Loan safety is monitored using liquidation thresholds and a health factor (Hf), where a Hf below 1 can trigger liquidation due to fluctuations in the value of collateral or borrowed assets. The liquidation process incentivizes third parties through bonuses to source and repay the debt, with oracles like Chainlink providing real-time off-chain asset prices to facilitate such liquidations.

It's worth noting that although this report primarily focuses on overcollateralized lending protocols such as Aave, there are various other smart-contract based lending protocols with distinct approaches. For instance, lending protocols like Goldfinch Finance and Maple, enable undercollateralized loans based on reputation and creditworthiness, while some platforms eliminate the reliance on external oracles or the need for governance. These approaches carry different trade-offs, highlighting the evolving nature of the DeFi lending space.

Now that we have gained some insight into the workings of lending protocols, let's apply our knowledge to a recent exploit on Aave and examine how the platform fared during a period of stress.

The Difference Between Protocol and Token

As alluded to earlier, most DeFi protocols use a governance process to make crucial decisions regarding their systems, such as the types of collateral accepted or the yields for specific markets. These governance decisions are facilitated via the token issued by the protocol, which grants its holder the right to vote on various proposals. As such, DeFi protocols tend to operate as Decentralized Autonomous Organizations (DAOs), entrusting their token holders with the management of the protocol.

It is crucial to distinguish between the protocol and its DAO token, even though they may share similar names. Take Aave, for instance. Aave is a lending protocol where users can lend and borrow crypto-assets via different products implemented as several interconnected smart contracts. Often, these protocols have different versions which attempt to improve upon previous iterations by introducing new functionality. In contrast, the AAVE token is the governance instrument used to manage the parameters and features of these smart contracts and is fundamentally implemented as an ERC-20 token.

Understanding this difference is paramount to successfully navigating the DeFi data landscape. On one hand, you have the protocol, which operates similarly to a financial institution. It issues loans, facilitates liquidations, implements markets, and provides a host of decentralized financial services. Much like a traditional financial institution, these protocols possess balance sheets and income statements and can be logically analyzed like a company. On the other hand, you have the governance token that commands the system, akin to units of common stock. This aspect of the system enables reasoning about ownership concentration, token free-float, and token turnover.

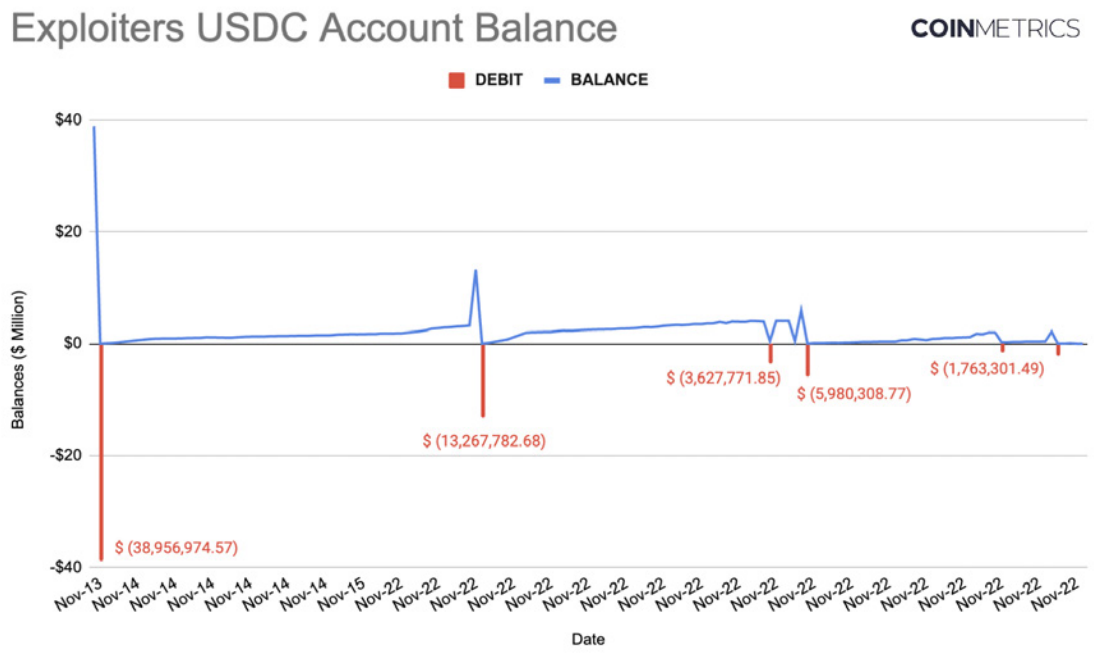
4 CASE STUDY #1 - BAD DEBT ON AAVE V2

To fully comprehend how these protocols serve as pseudo-financial institutions, let's examine a case study that demonstrates their handling of debt. In November 2022, the Aave protocol had to write off losses amounting to $1.6 million. This incident occurred after a user undertook a series of highly leveraged trades involving a specific token available on the platform. Although the intentions of the perpetrator still remain unclear, his actions initiated a series of noteworthy events with implications for the protocol's financial health.

At the heart of this exploit was a sizable loan of the Curve DAO token (CRV) procured on Aave V2 . As collateral, the user posted a large sum of USDC, which was rehypothecated (re-used) to additionally fund the postion. Protocols like Aave facilitate both lending and borrowing, but cannot differentiate when both borrowers and lenders are the same entity. In other words, a user can lend 100M USD on the platform, borrow CRV on the basis of that collateral and, with another account, lend the CRV back to the platform, which unlocks additional liquidity. While this strategy is commonly employed to achieve higher leverage in DeFi, it carries substantial risks.

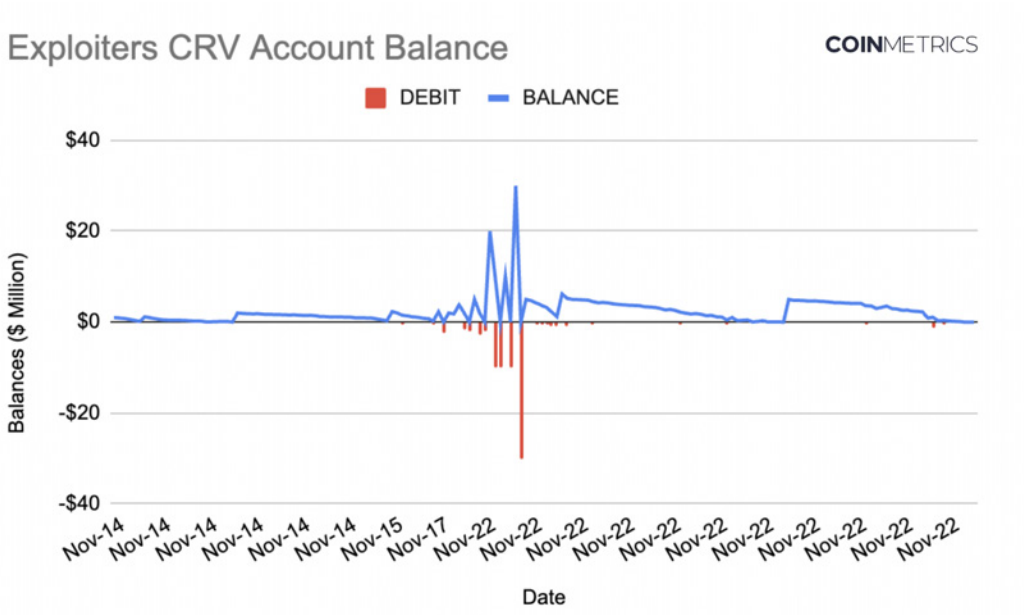
The loan resulted in a substantial drain on liquidity from the CRV market on Aave, subsequently leading to a decrease in its value over time. The ensuing volatility sparked a liquidation process, ultimately forcing Aave to write off a large position. To form a holistic understanding of events that unfolded, we can examine data highlighting the attacker's account activity. We can also contextualize the risks associated with Aave's lending markets via the lens of a balance sheet, much like a traditional financial services provider.

At a high level, the short sell unfolded as follows. Initially, the exploiter accumulated a large position of USDC, presumably procured either from an exchange or directly from the Circle treasury, the issuer of USDC. This USDC position was then utilized as collateral to obtain a loan on CRV on Aave v2. The CRV accumulated by the exploiter was subsequently sold on exchanges for USDC, creating a downward pressure on the price. Funds were then sent back to Aave, thereby unlocking additional liquidity. The alleged exploiter, Avraham Eisenberg, used the following address to carry out the attack. This address was funded by the ponzishorter.eth ENS account and was associated with the exploit of another marketplace called Mango Markets. Both of these connections have previously been linked to Eisenberg. The chart below depicts the balance of USDC in this account from November 13, 2022 to November 22, 2022.



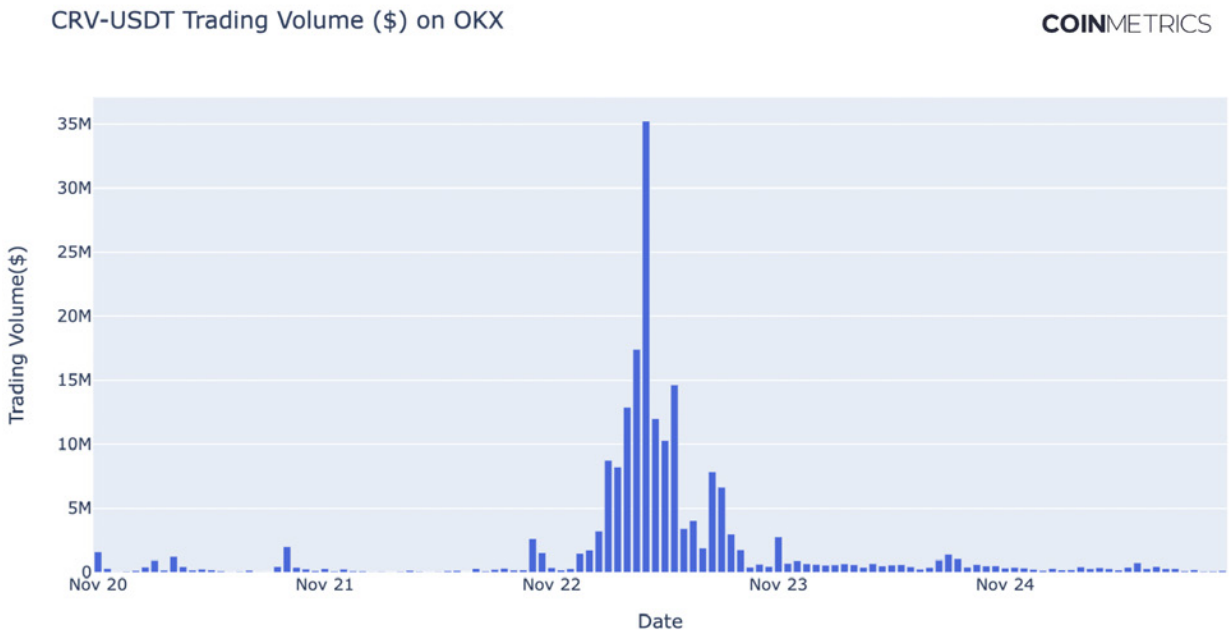
Source: *Coin Metrics' ATLAS v2*

As seen in the chart above, the attacker's wallet was debited $39M USDC, which was subsequently sent to Aave v2. Following this initial transaction, Eisenberg built up his USDC position for over a week leading up to November 22nd, when the CRV short occurred. A cumulative value of $64M USDC was transferred out of the wallet, forming his collateral position on Aave.



Source: *Coin Metrics ATLAS v2*

In contrast, the account displayed a series of CRV inflows, acquired as debt from Aave, eventually totaling $39M. Subsequently, Eisenberg transferred the obtained CRV to an intermediary address and then proceeded to sell it on OKX, a digital asset exchange. This aligns with a strategy known as "looping," wherein Avi would deposit USDC, borrow CRV using their USDC as collateral, and sell the borrowed CRV on centralized & decentralized exchanges and repeat the process. It's worth noting that trading volume for the CRV-USDT pair was significantly higher than CRV-USDC, suggesting that Eisenberg sold his CRV on OKX to primarily acquire USDT. The shorter leveraged their collateral to acquire successive loans, increasing their USDC holdings via "rehypothecation".



[Speculation] arose that the attack was targeted at liquidating Michael Egorov, the founder of the decentralized exchange Curve Finance, who held a significant deposit of $48M CRV on Aave at the time. With a 87% Loan-to-Value ratio for providing USDC as collateral, Avi accumulated a substantial CRV loan, valued at around $40M. As seen below, these actions exerted significant downward pressure on CRV token's price, posing a risk of liquidation for Egorov's large position in addition to other CRV depositors.

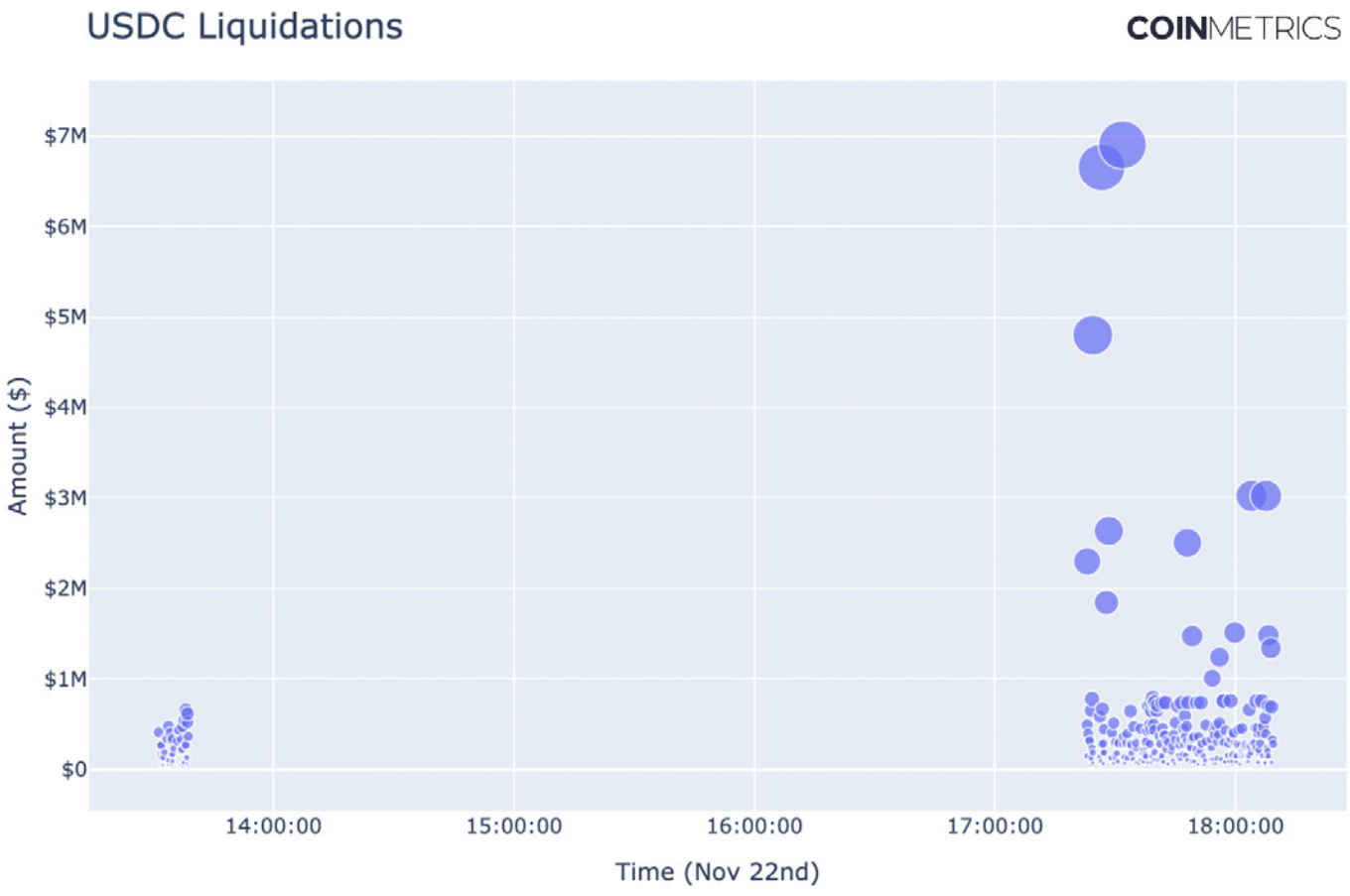
Source: *Coin Metrics Reference Rates*

Amidst this, Curve introduced a whitepaper for its native stablecoin crvUSD which had a significant impact on price action, causing it to swing in the opposite direction and surge from a low of $0.40 to above $0.70. Consequently, as the value of the borrowed asset CRV increased, the exploiter's position approached the liquidation threshold, increasing the likelihood of liquidation.

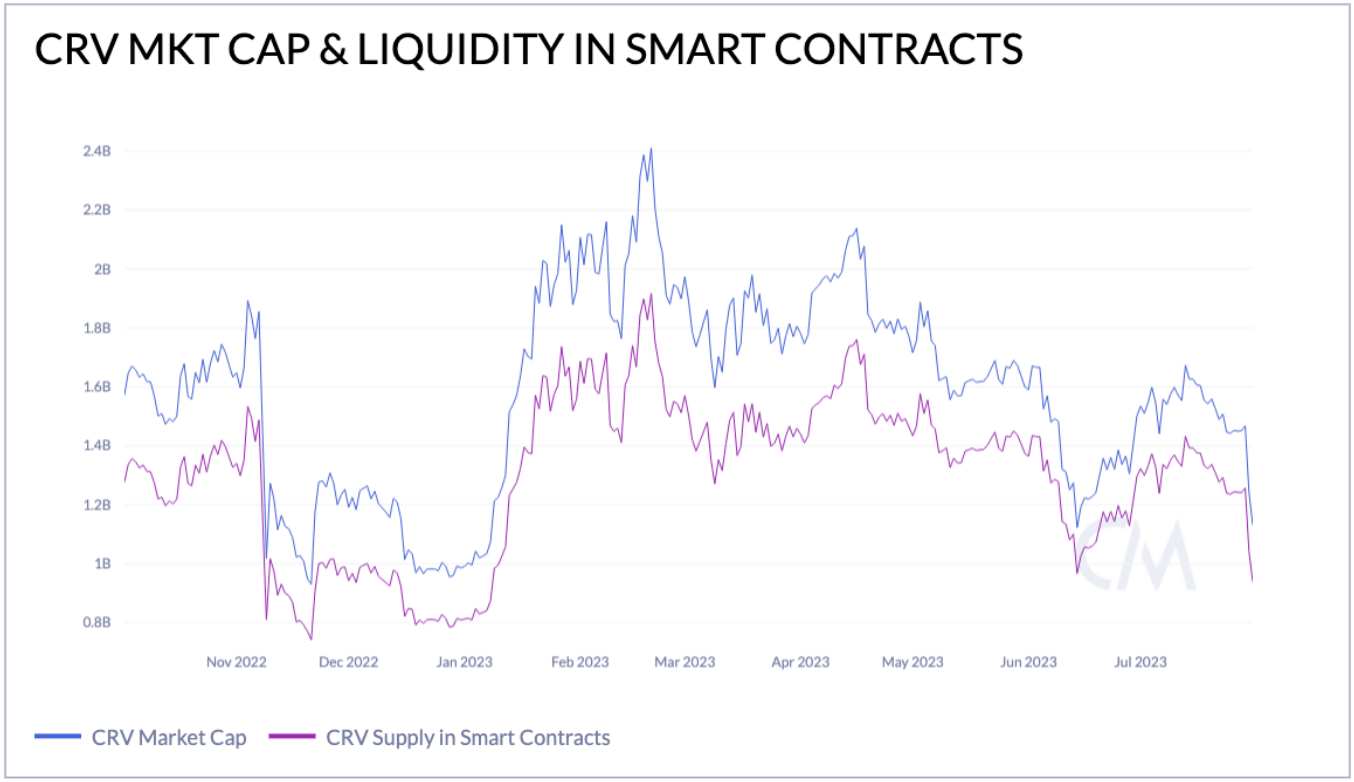
Loan to Value Ratio (LTV) = Borrowed Amount/Value of Collateral

Initial LTV (CRV Price = $0.4)	*New LTV (CRV Price = $0.7)*
*Initial LTV = ($40,000,000 / $64,000,000) * 100* *Initial LTV = 62.5%*	*New LTV = ($70,000,000/ $64,000,000) *100* *New LTV = 109.4%*

With a new loan-to-value ratio of 109%, Eisenbergs position surpassed the 85% liquidation threshold as the price of CRV rose, thereby triggering a liquidation.

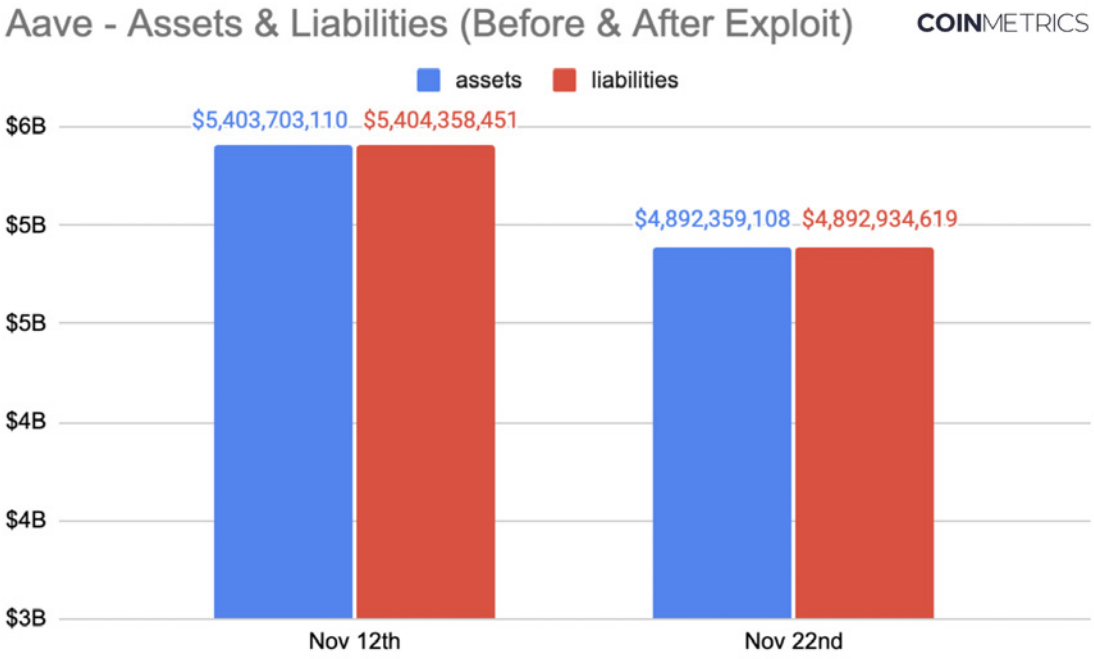


Liquidations of Eisenberg's defaulted loan commenced, with 354 liquidation call transactions (the mechanism used for on-chain liquidations) and 21 unique liquidators participating. When a liquidation process is triggered, liquidators attempt to source and repay the borrower's debt (CRV) in order to receive the collateral asset (USDC) at a discount. As seen in the chart above, liquidations occurred in batches as sourcing CRV to repay the debt was unprofitable for liquidators due to depleted CRV liquidity on-chain.



Source: *Coin Metrics Network Data*

Given the liquidity constraints and subsequent pricing abnormalities, liquidators were unable to source the equivalent amount of CRV to replenish the loans made to the exploiter. This resulted in a total discrepancy of $1.6M which can be conceptualized as a default, given that a portion of the debt remained unpaid. When the liquidation mechanism fails, as was the case here, these losses must be socialized by token holders. Governance ultimately convened on repaying the deficit via Aave's *collector contract*, procuring $2.5M CRV with aUSDC holdings from the contract. For context, Aave's collector contract holds proceeds from fees charged to interact with Aave. These can be spent via a governance process such as the one described above.

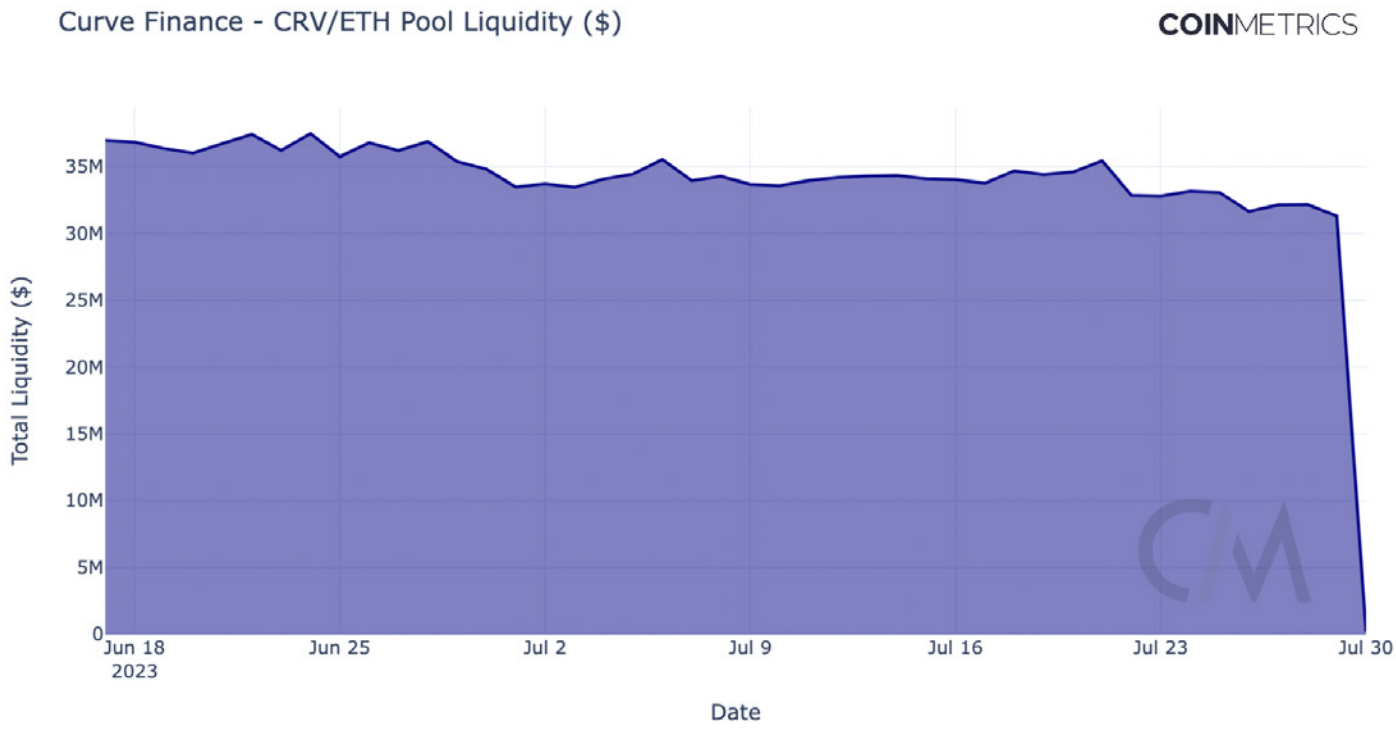


Source: *DeFi Balance Sheets*

Assets on Aave's balance sheet consist of loans lent by the protocol (user borrows) in addition to total value locked (assets that haven't been lent out). Liabilities on the other hand are represented by user deposits, as the protocol issues aTokens as a claim on deposits. As this provides a snapshot of the balance sheet at points in time, discrepancies between assets and liabilities could be a result of user activities such as borrows or repayments. The delta between assets and liabilities on the two days can help us approximate bad debt, which amounts to $1.07M. This also includes the protocol's earnings or losses across its other markets over the time period, therefore deviating from the expected $1.6M deficit incurred. The large drop between the dates can be therefore attributed to the loan default and subsequent liquidation process, which results in USDC being sold at a discount (decrease in liabilities) to repay CRV (decrease in assets).

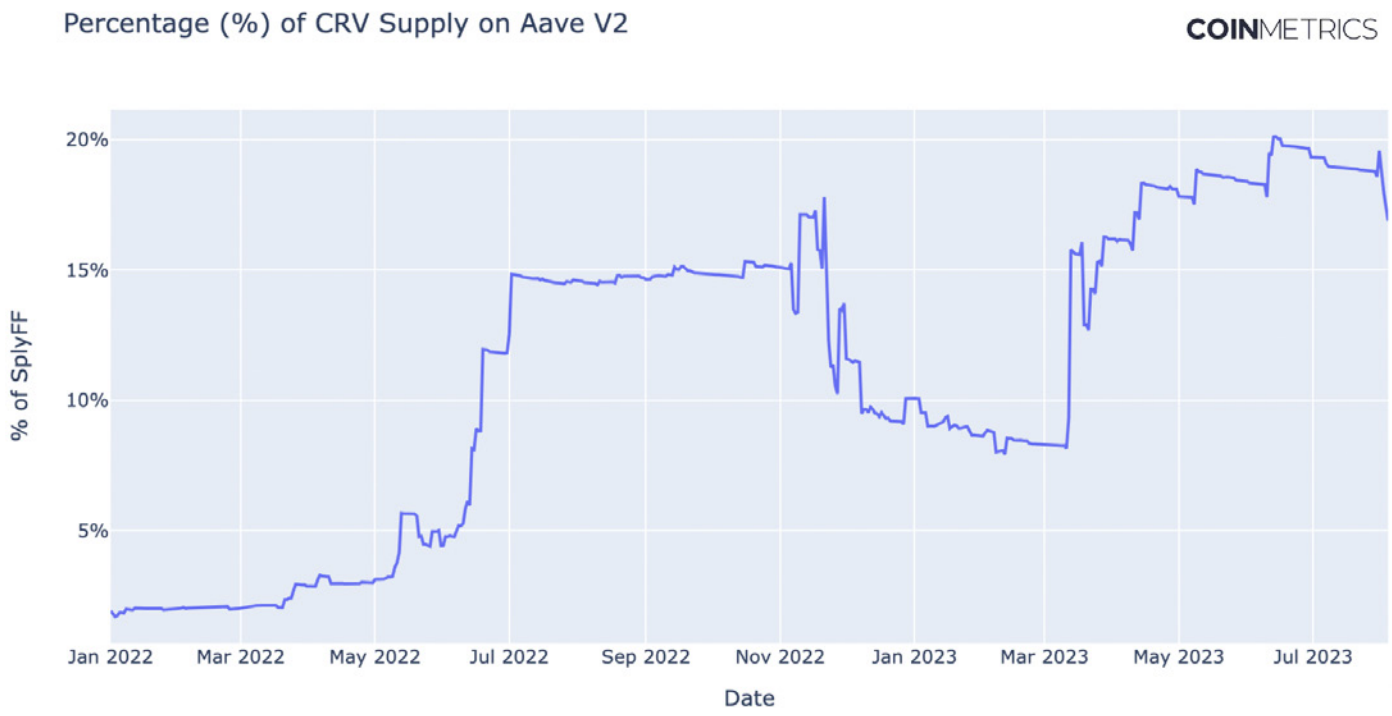
5 CASE STUDY #2 - CURVE FINANCE CASCADE

On July 30th, Curve Finance—a popular decentralized exchange on Ethereum—suffered an exploit due to a "malfunctioning re-entrancy bug" in versions of Vyper, a smart-contract language. This compromised the protocol's security, resulting in a loss of funds from 4 pools. Coin Metrics' DeFi Balance Sheets data show that Curve's total value locked (TVL) approximately halved to $1.24B as liquidity providers rushed for the exit from several other pools. Of these, the CRV/ETH pool—a large source of on-chain CRV liquidity—was drained of $32M CRV. The exploiter was able to retain 7.1M CRV tokens in an associated address.



As the price of CRV dropped rapidly, contagion from the Curve platform was at risk of spreading to other protocols with exposure to the token. Of particular importance are money markets or lending protocols with exposure to CRV collateral as they face a severe risk of liquidation and bad debt accumulation. As we covered in the previous case study, Michael Egorov, the founder of Curve was a victim of Eisenberg's Aave exploit due to his large loan ($48M at the time). He once again finds himself in a dire position, with his debt swelling to 63M USDT, collateralized by ~300M CRV on Aave

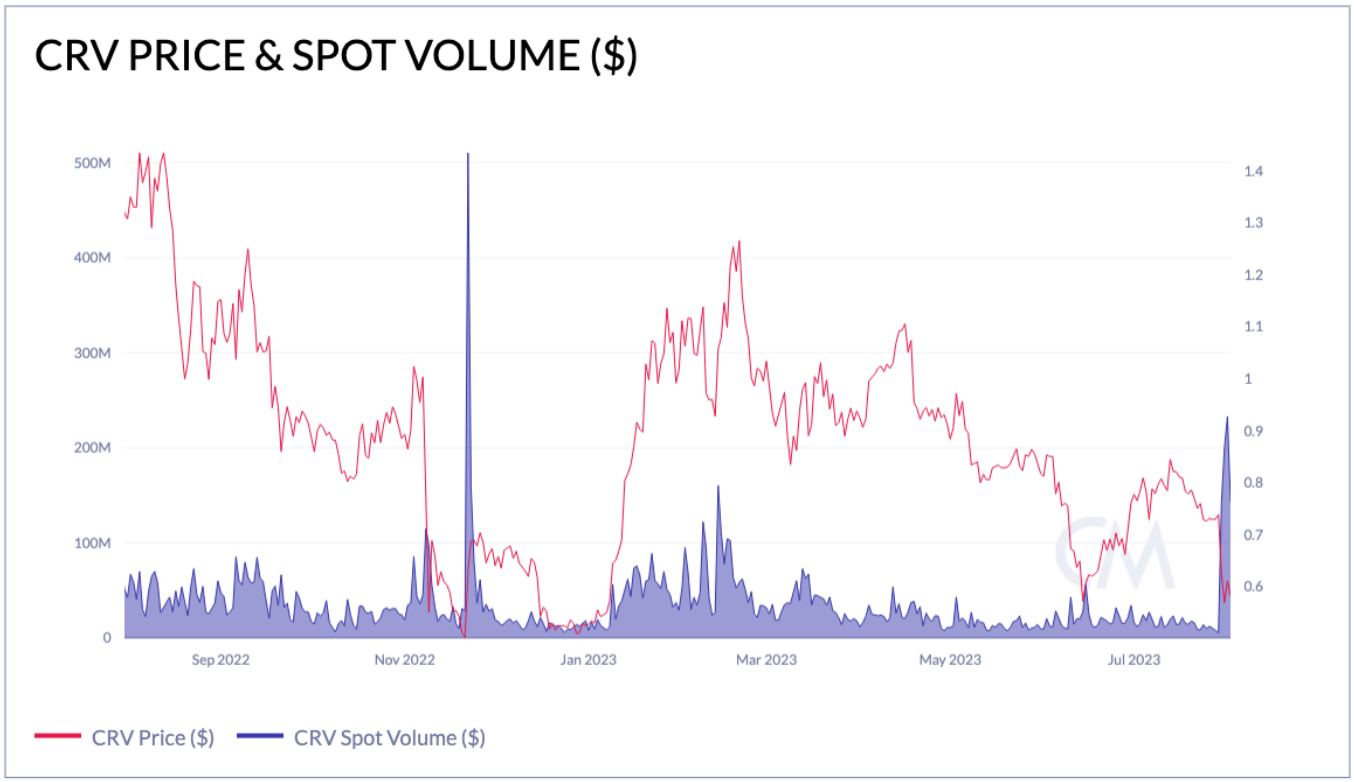
v2. The highly concentrated nature of this collateral position has been a [frequent topic] of concern amongst the Aave governance forum, which re-ignited due to fears of bad debt from incomplete liquidations amidst CRV illiquidity and volatility. As seen below, CRV exposure on Aave, reached above 20% of free float supply, highlighting its highly concentrated nature. At a liquidation threshold of 55%, this position would be eligible for liquidation if CRV price approaches $0.37. If liquidations were to occur, Aave would need to tap into its "Safety Module", an [insurance fund] consisting of staked Aave tokens (stAAVE), to backstop the losses potentially adding pressure to AAVE price as well.



Source: *Coin Metrics Network Data & DeFi Balance Sheets*

Additionally, Egorov also held a deposit of 59M CRV on Frax Finance, with an outstanding loan of 15.8M FRAX. This exposure also posed a significant risk due to the platform's [mechanics], where interest rate doubles every 12 hours when at a 100% utilization rate. If liquidations were to occur, it could add further selling pressure on the CRV token, potentially impacting his larger position on Aave v2, with cascading implications throughout the DeFi lending ecosystem.

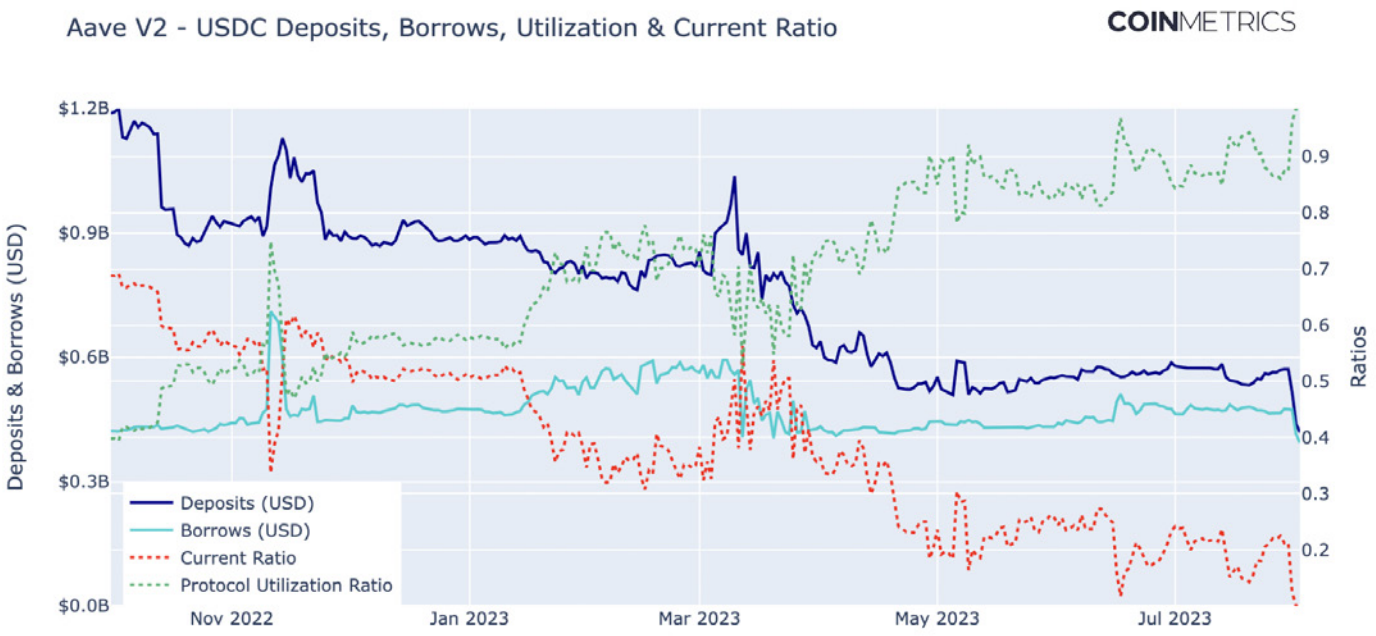
The situation remains contained for now as Egorov has been selling CRV via over-the-counter (OTC) deals to obtain stablecoins and repay his loans. However, this event underscores how composability amongst DeFi platforms can be a boon but also a cause for potential spillover contagion.



Source: *Coin Metrics Charting Tools*

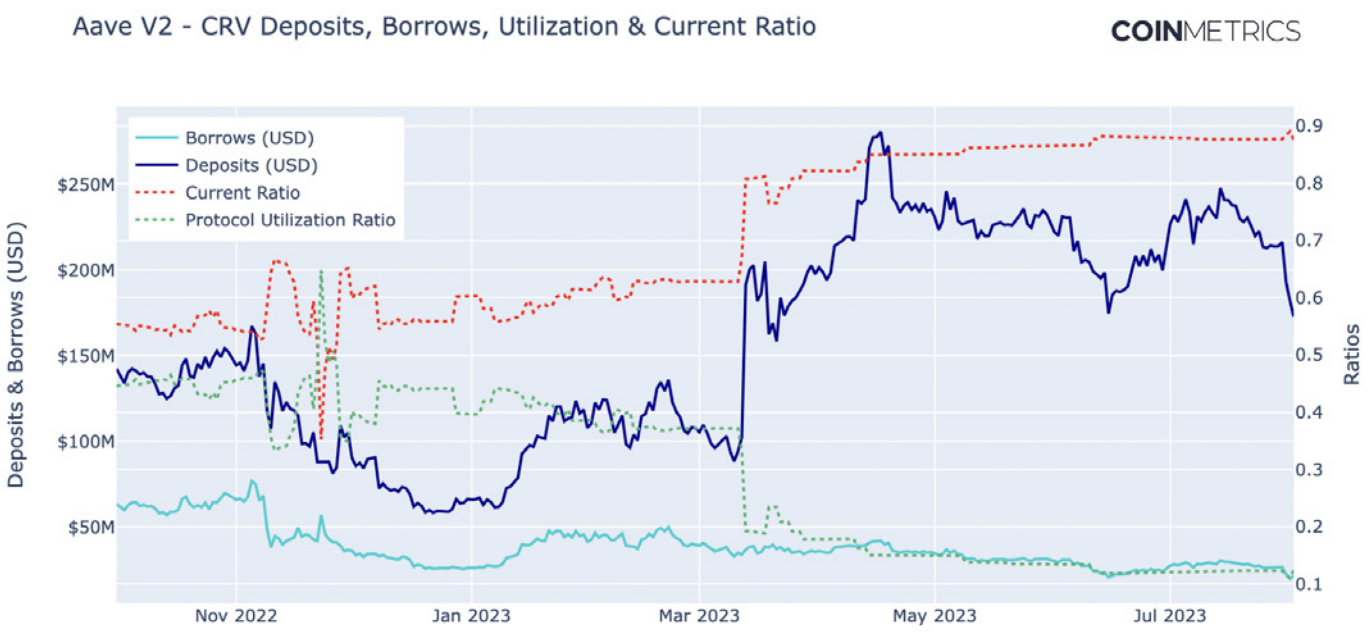
6 CONTEXTUALIZING THE "HEALTH" OF DEFI LENDING MARKETS

Examining the financial health of the Aave protocol reveals crucial insights into its various markets. Balance sheets—a widely used tool to assess a company's financial performance—can also be leveraged when evaluating DeFi markets. They offer a holistic view of a protocol's assets and liabilities, allowing users to monitor, analyze, and reason about its overall financial health.



Source: DeFi Balance Sheets

Akin to capital deposited by customers at a bank, user deposits on Aave can be treated as liabilities on the balance sheet since liability tokens (aToken) are issued to users upon making a deposit. As seen in the chart above, a spike in utilization to over 70% is evident as available USDC capital is borrowed from the pool on November 13th. Conversely, the current ratio, which portrays the percentage of supply that can be used for loans, experiences a drop to 30%. Eisenberg's provision of USDC to collateralize his loan on November 14th subsequently causes a drop in utilization as available capital within the pool increases.



Source: DeFi Balance Sheets

On the other hand, loans lent by the protocol can be viewed as assets (receivables) on the balance sheet with users expected to repay their loans. Keeping the case study events in focus, a spike in utilization, and drop in current ratio is visible around November 22nd as Eisenberg steps up his CRV borrows—indicating that the CRV pool has experienced a sudden increase in usage. Due to the volatile nature and oftentimes concentrated ownership of DeFi governance tokens, assets like CRV aren't ideal forms of collateral and therefore experience lower utilization. In this case, CRV utilization jumping to 65% signified that capital in the pool was becoming scarcer. This is of particular importance, as Aave realized bad debt due to increased volatility and illiquidity of CRV.

The events described in the second case study are also visible in this chart. A drop in utilization to below 0.2 is evident in March 2023, this time as a result of Michael Egorov stepping up his CRV deposits. With his position representing a significant portion (>90%) of total deposits, utilization of the CRV pool has remained at low levels. The effects of his loan repayments are also visible, with total CRV deposits declining as he redeems his collateral.

Thus, as illustrated by this example, monitoring changes on the balance sheet can provide valuable insights into underlying markets of a DeFi protocol and allow users and stakeholders to mitigate imminent risks in a timely fashion.

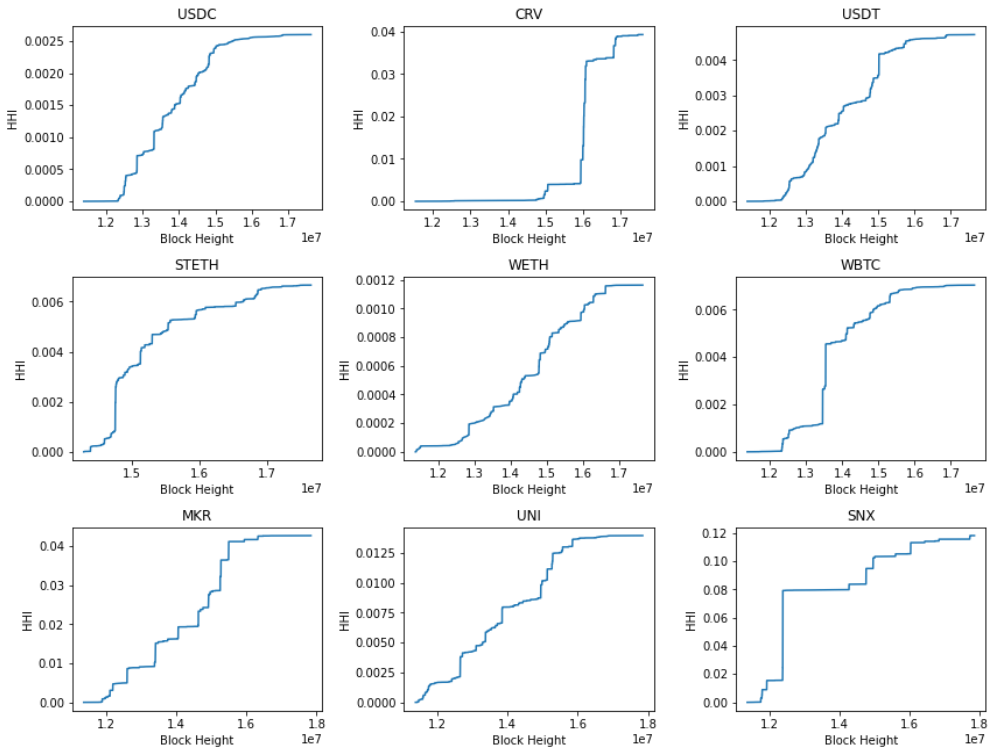
7 RISKS IN DEFI LENDING MARKETS

7.1 Concentration Risk

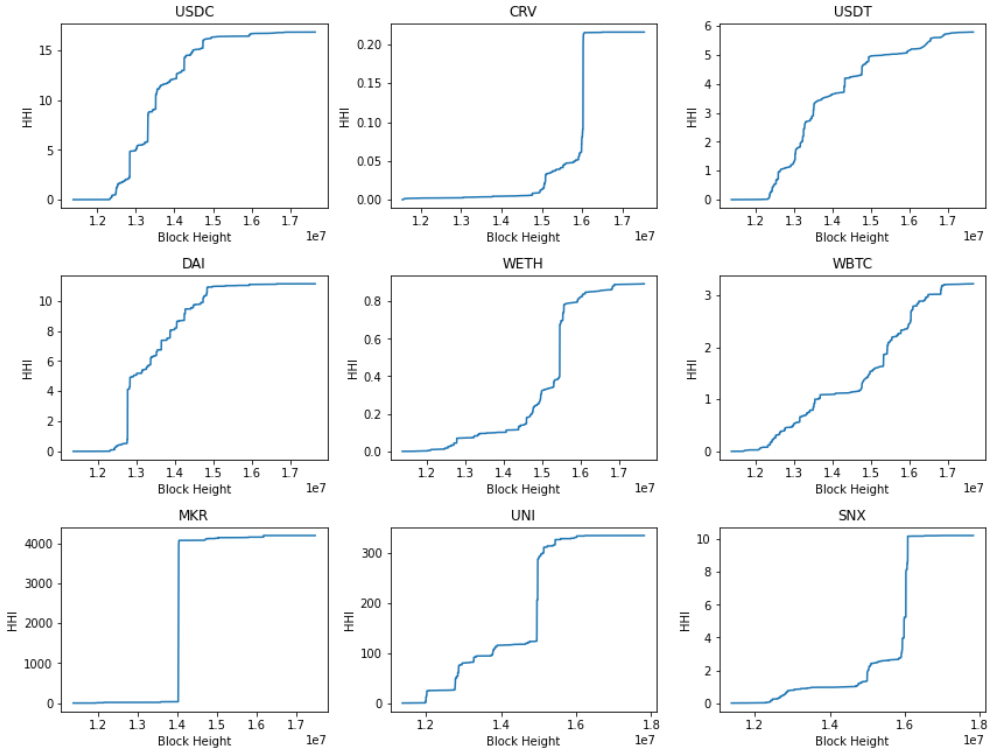
Within the context of DeFi lending markets, borrowers seeking loans are interdependent on lenders providing capital forming a symbiotic relationship between the stakeholders. Therefore, when a disproportionate amount of supply becomes concentrated within the hands of a few participants, it can lead to several risks for both borrowers and lenders, potentially undermining the stability and effectiveness of the lending ecosystem.

The Herfindahl Hirschman Index (HHI) is a widely used metric for measuring market concentration of an industry. This metric is calculated by squaring the market share of each participant in the industry, then adding up these squared figures. In other words, each token holder's ownership share is multiplied by itself, and then these results are combined for the total index score. The higher the HHI value, the more concentrated the monetary base, indicating that a small number of entities hold a significant share of the total supply. Applying this metric in the context of DeFi lending markets like Aave v2, HHI helps gauge supply concentration for both lenders and borrowers in major lending pools, revealing their concentration profiles and potential risks.

Aave v2 - Deposit Pool HHI by Asset



Aave v2 - Borrow Pool HHI by Asset



This metric can help reveal several potential risks to lending markets such as:

Liquidity Risk: When a significant portion of the total supply is held by a few lenders, the market becomes susceptible to disruptions caused by actions of those dominant players. For instance, if a major lender suddenly withdraws their funds, it could trigger a liquidity crunch, making it difficult for borrowers to obtain loans, leading to increased volatility.

Counterparty/Default Risk: Conversely, if a significant portion of assets are controlled by a few borrowers, lenders exposure to counterparty risk increases. If one or more of these major borrowers default on their loans, it could lead to significant losses for the lenders, potentially affecting the stability of the entire lending market and the protocol itself. As seen in the case study we highlighted, Eisenberg's default on his significant CRV loan resulted in a period of financial distress for the Aave protocol.

Centralization Risk: DeFi lending markets are designed to operate in a decentralized and trustless manner. However, high levels of concentration can lead to concerns around centralization, as a few significant actors may influence the decision-making process and undermine the decentralized nature of the ecosystem, thereby putting other users of the platform at risk.

Although this report focuses on vulnerabilities pertinent to the DeFi lending sector, Coin Metrics has previously covered another significant risk affecting the entire decentralized finance space. Namely Admin Keys, which is thoroughly covered in "Monitoring DeFi's Biggest Risk."

7.2 **Governance Risk**

DeFi protocols are governed by decentralized autonomous organizations (DAOs), enabling stakeholders to collectively influence the protocol's rules and operations. Holders of the governance token can propose, discuss, and vote on changes, including codebase modifications, approved collateral, and risk parameters. While this reduces reliance on central authorities and fosters stakeholder alignment, several frictions still exist.

The dynamic and unpredictable nature of markets cannot be anticipated by smart-contracts alone, and therefore active human intervention is required via the governance system to adapt to external events. Oftentimes, this means that changes to protocol parameters are reactive rather than proactive. Additionally, token-holder activism can also present several risks, as few large token holders can heavily influence the decision making process, potentially jeopardizing the entire system.

In light of the events the Aave protocol experienced, participants and community members took several measures through Aave's governance forum to mitigate the risks associated with the protocol. This included the reconfiguration of parameters for 17 asset reserves on the Aave v2 Ethereum Market, and discussions around the optimization of the loan-to-value (LTV) and liquidation thresholds for assets susceptible to such manipulation attacks. Furthermore, Michael Egorov's large loan was also a central topic of discussion with the community members suggesting migration to Aave V3, which employs more granular risk measures such as borrow and supply caps.

Although these measures address the short term risks faced by DeFi Lending protocols, such attack vectors are still possible due to the inherent transparency of blockchains. Bad actors can use this elevated access to information to their advantage under different situations and market conditions. Therefore, this begs the larger question: how can such risks be managed in a more timely or proactive manner?

8 CONCLUSION

Decentralized Finance (DeFi) and its constituent lending applications offer several advantages through increased transparency, accessibility and automation underpinned by smart-contracts and pool based lending. However, as a nascent and developing sector of the digital asset ecosystem, these platforms are exposed to significant risks. As exemplified by the case studies we covered, the risk of concentration and reliance on reactive governance measures are prominent concerns. Additionally, while the notion of “money-legos” and interoperability amongst applications unlocks greater capital efficiency, it can also have severe implications for the stakeholders and users of these platforms when things go wrong. Finally, while full transparency is a novel feature over traditional intermediated lending, the ability to track all users’ positions and liquidation thresholds in real time allows adversarial actors to constantly calculate the benefit and cost of any attempted attack.

In light of these risks, the DeFi ecosystem must prioritize proactive measures to improve security and risk management. A crucial aspect involves prudent monitoring of the health of underlying markets and implementing better risk controls. Coin Metrics' comprehensive dataset, including Network, market, and DeFi Balance sheet data, offers valuable insights for monitoring these markets effectively. By taking steps to strengthen protocol infrastructure and implementing external risk management measures, DeFi lending can fully realize its potential to revolutionize finance while ensuring a safer and more resilient ecosystem.

9 DATA APPENDIX

This data appendix provides more information about metrics used in this analysis and how they can be derived or calculated. The data was obtained from Coin Metrics DeFi Balance Sheets endpoint, and the following metrics were calculated to gain insights into risks faced by DeFi lending protocols.

1) **Deposits:** Deposits on Aave represent liabilities for the protocol. A receipt on a users deposit is issued via aTokens, allowing users to redeem their deposit and accrued interest.

   Deposits = liabilities_total_usd

2) **Borrows:** Borrows on Aave represent the loans lent by the protocol. Capital borrowed by users is expected to be repaid, thus representing assets (receivables) on its balance sheet.

   Borrows = loans_lent_total_usd

3) **Total Value Locked (TVL):** The Total Value Locked (TVL) of the protocol represents the assets that are within the protocol which have not been lent out. In other words, the difference between TVL and Total Assets represents the aggregate value of loans made by the protocol.

   Total Value Locked (TVL) = tvl_total_usd OR (assets_total_usd – loans_lent_total_usd)

4) **Utilization Ratio:** The utilization ratio represents the percentage of deposited capital being borrowed. Therefore, each underlying pool/market experiences different utilization based on the amount of loans being lent out from deposits

   Utilization Ratio = loans_lent_total_usd/liabilities_total_usd

5) **Current Ratio:** In lending protocols, the current ratio can be interpreted as the percentage of the supply allocated to the protocol that is liquid and can be used for loans.

   Current Ratio = tvl_total_usd/liabilities_total_usd

DEFI'S DOUBLE EDGED SWORD

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