Capital at Risk - Simulation Model Report

Background

With the rapid growth of SparkLend to more than $3B in supplied amount, it's becoming increasingly important to build a robust risk methodology to evaluate the protocol's economic risk under various stress-testing scenarios.

This report presents the methodology and initial results for Capital at Risk, a portfolio-level estimation of potential bad debt based on stress-testing of various market risk scenarios. More specifically, we simulate different scenario combinations of price shocks, liquidity, and protocol growth trajectories. Its key aim is to provide a simple-to-understand methodology with intuitive, actionable insights and add additional complexity over time.

Important to mention is that the model (as any quantitative model) includes some subjective assumptions that can always be argued against. We intend to provide the underlying assumptions transparently, share our views based on industry experience over the years, and focus on a few questions that we identified as key to understanding the economic risk of SparkLend.

For example, the questions of "what kind of market shock should the protocol be protected against" or "what kind of protocol losses are the users and/or token holders willing to tolerate" have no objective value, especially when considering also the aim of optimizing protocol growth by increasing capital efficiency.

Among other examples is also the difficulty in estimating the negative long-term consequences of different bad debt events on protocol growth. For this reason, we chose to model market dynamics that fall within the quantifiable known-unknowns territory.

There are two main reasons we developed this risk model. It will help us to better understand the risks related to economic dynamics in the protocol and allow for more efficient and precise parameter configurations based on various factors. The second reason is related to Endgame and AllocatorDAOs, which will be required to maintain a certain level of junior capital based on their exposure. This model is the first step for determining AllocatorDAOs junior capital requirement concerning assets exposure deployed in Spark and potentially future similar market instances.

Methodology

In DeFi lending context, slippage indicates how much loan exposure can be profitably liquidated onchain. The drainage of available liquidity introduces the risk of protocol losses (bad debt). Bad debt arises when the debt amount is higher than the collateral amount with neither incentive nor possible enforcement for the user to repay their debt. This guides the setup and output of the risk model.

The model takes the current asset liquidation thresholds (margin requirements) and SparkLend wallet positions as input to simulate the slippage and bad debt figures.

It can also be used to simulate different liquidation threshold (LT) values with behavioral assumptions of users to the parameter change. For example, if we assume an increase LT by x% and either simulate that users respond to the change (e.g. increase their borrow) or not (the positions stay the same). In the former case, the protocol risk increases while in the latter case, the risk remains partially the same (but can increase in case of market liquidity drain due to liquidations across other protocols that can have a lower gap to LT).

The model simulates a specific instant price shock (currently set conservatively at 40% in the asset-level analysis) for non-pegged pairs and a specific depeg shock (currently set to 20%) to simulate its output. This simulates the shock velocity during which position owners don't have time to respond, including positions managed with bots, an assumption set intentionally conservatively.

A single number interprets the results and provides clearer guidance ("the protocol is protected against an X% price shock"). The instant price shock is used because, in the case of a gradual price decrease, users are likely to respond (which would also need to be estimated). Also, in that case individual positions trigger multiple smaller liquidation chunks which are unlikely to cause bad debt, unless there is a major drainage of the market's liquidity causing a liquidation spiral. The model is meant to be a high-level guidance on the parameter setting, aiming for simplicity, and can be extended in complexity over time if necessary.

To estimate liquidity available for liquidations we use profitable DEX liquidity. This is computed by retrieving liquidity at 50% of the collateral asset's liquidation bonus to add a conservative assumption of liquidation profitability. Wallets are liquidated based on size, offloading the available liquidity with 50% of the borrow position size liquidated. When all of the liquidity is drained, the remaining wallets are not liquidated in the simulations with the potential to directly contribute to bad debt (if the price shock is sufficient given their health rate).

To sweep across various scenarios and their impact on CaR (bad debt), the model can iterate over different scenarios of supply growth, liquidity changes, and price shocks.

Supply growth scenarios show the relationship between protocol growth and bad debt and can inform how much exposure is governance willing to take on without being at risk of large losses. Supply growth iterates over the multiples of the current market state, from the current state to 10x of its size.

Liquidity changes which are partially a function of market expansion/contraction (among other factors) play a crucial role in how much liquidation volume can the ecosystem handle during various stress-testing events. As a rule of thumb, empirical data shows that each 10% increase in asset price increases DEX liquidity by 5% (2:1 relationship). This can be useful to imagine how different market trajectories can impact liquidity constraints.

Simulated price shocks test whether the health rate buffers are sufficient and if not, positions are liquidated, assuming enough market liquidity.

We tested also more sophisticated price shock scenarios in the past (e.g. jump diffusion GBM) which be a better representation of price trajectories. Meanwhile, we acknowledged that subjectivity of inputs is not solved, it mostly only becomes more hidden and less intuitive to interpret.

Additionally, while it's less relevant in the current setup with only stETH, WETH, and rETH as simulated collateral assets (reasoning explained below), the model applies a jump multiplier by increasing or decreasing the baseline (ETH) price shock. For example, the price shocks of WBTC have been historically less severe than ETH while most long-tail assets showed more sensitivity to general market shocks (we apply a 70% share of baseline price shock which is based on ETH historical patterns).

The current market state is split across each collateral asset, filtering out the wallets where the chosen collateral asset is also the largest asset by wallets' supply size. This determines the market risk per specific collateral asset with the assumption that the largest collateral asset in the wallet will likely be chosen to be liquidated by liquidators. This has mostly been the case based on historical data with the rare exceptions of positions whose largest collateral asset was highly illiquid. Additionally, supply growth simulates a proportional increase in the market size. While the identical composition of position states with protocol growth is unlikely to play out exactly, we preferred this scenario modeling choice over adding more behavioral assumptions. This can, along with the other parts of the model setup, change if necessary.

Analysis (Collateral Asset Risk)

When filtering wallets that have some debt exposure based on their dominant (largest) collateral assets, two of them (wstETH and WETH) contribute to 90% of the total supply. For demonstration purposes, we decided to add also sDAI to the asset-level analysis.

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Each collateral asset includes the following sections:

- Liability distribution

(standard and e-mode when relevant)

- Market Size

(filtered wallets based on the largest supply asset)

- Health Rate Distribution

(how close to liquidations are filtered wallets)

- Simulation Results - Profitable Liquidity

(available liquidity for liquidations assuming profitability based on set liquidation bonuses)

- Simulation Results - Liquidations at Risk

(how much collateral is liquidated, capped by profitable liquidity)

- Simulation Results - Capital at Risk

(bad debt caused by the simulated market shock)

wstETH

Liability Distribution

Debt, collateralized with wstETH comes mostly from DAI (long wstETH), contributing to the most market risk from standard positions.

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When looking at e-mode, most of the liability comes from WETH, as expected given the large demand for leveraged staking yield.

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Market Size

Because both standard and e-mode positions can be collateralized by wstETH, we are simulating the price shock of the underlying (ETH) and wstETH depegging. Together they contribute to potential bad debt (CaR).

170 wallets have wstETH as their largest supply asset with a total supply amount of $1.28B and $715M in borrow amount.

Market Collateralization

The chart below shows that almost half of the borrowed amount has a health rate lower than 1.1, mostly based on recursive leverage positions. Around $200M is coming from a single wallet.

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Simulation - Profitable Liquidity

Relevant profitable liquidity for wstETH as collateral comes with both DAI (standard positions) and ETH (e-mode). These are stacked in the chart below.

We see an increase in profitable liquidity with the increase in long-term market prices, from a 40% decrease from the current liquidity levels ($25M in liquidity for general market shocks) to a 40% increase above the current prices ($125M in liquidity for depeg market shocks).

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Simulation - Liquidations at Risk

The chart below simulates both a change in liquidity and an increase in supply (starting from the current state) with increments of 2x, 3x…up to 10x of the current market size.

The current liquidity conditions can be found at the level where Liquidity Change is at 0%.

Liquidations at Risk are capped at the available profitable liquidity, the unprofitable liquidations turn into bad debt with a sufficient price shock.

We see that all of the liquidity is drained from the market with the extreme stress test that is simulated given the large market size. This causes remaining under-collateralized wallets to contribute to bad debt which is shown in the next chart.

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Simulation - Capital at Risk

Simulation of bad debt shows that protocol losses are determined largely by an increase in the market size (y-axis changes), much less so based on the profitable liquidity (x-axis changes).

At the current market size, with no change in liquidity and the applied extreme stress test, the protocol could experience a loss of $13M. That increases with the increase of supply (x-axis changes).

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WETH

Liability Distribution

In standard mode with WETH as collateral,most wallet debt comes from DAI (long ETH, similar to wstETH).

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Market Size

497 wallets have WETH as their largest supply asset with a total supply amount of $669M and $298M in borrow amount.

Market Collateralization

There’s much less e-mode debt, collateralized by WETH compared to wstETH which shows up with a minimal concentration of debt close to a health rate of 1.

Most of the borrow amount has a health rate larger than 1.5.

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Simulation - Profitable Liquidity

Profitable liquidity of WETH as collateral uses pair liquidity of WETH:DAI.

The chart below shows an increase in profitable liquidity with the increase in long-term market prices, from a 40% decrease from the current prices ($12M in liquidity) to a 40% increase above the current prices ($28M in liquidity).

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Simulation - Liquidations at Risk

The chart below simulates both a change in liquidity and an increase in supply (starting from the current state) with increments of 2x, 3x…up to 10x of the current market size.

The current liquidity conditions can be found at the level where the Liquidity Change % is at 0.

Liquidations at Risk at capped at the available profitable liquidity, the unprofitable liquidations turn into bad debt with a sufficient price shock.

Similar to wstETH simulation results, not all simulated scenarios drain all of the market liquidity.

The chart also shows that there is more sensitivity to market size growth (x-axis changes). Same as with wstETH, the drained liquidity causes the remaining under-collateralized wallets to contribute to bad debt which is shown in the next chart.

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Simulation - Capital at Risk

At the current market size, with no change in liquidity and the applied extreme stress test, the protocol could experience a loss of $4.3M. That increases with the simulated supply (x-axis changes) where a 10x increase in market size and the applied stress test contribute to a loss of $59M.

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sDAI

Liability Distribution

While much of sDAI supply comes from supply-only wallets, most of the debt, collateralized by sDAI comes from WETH (short ETH).

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Market Size

17 wallets have sDAI as their largest supply asset with a total supply amount of $120M and $39M in borrow amount.

Market Collateralization

The market is dominated by a single wallet with a health rate of around 2.3 which makes the market very safe.

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Simulation - Profitable Liquidity

The profitable liquidity comes from WETH/DAI as a proxy for given sDAI’s liability distribution and strong sDAI/DAI liquidity.

The chart below shows an increase in profitable liquidity, from a 40% decrease from the current level ($12M in liquidity) to a 40% increase above the current level ($28M in liquidity).

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Simulation - Liquidations at Risk

For consistency, despite sDAI:WETH representing short positions, are are still simulating price drops which can otherwise be quickly changed into a price increase.

Even with that, there is a minimal amount of liquidations at risk, mostly coming from a single wallet which has a proportionally high amount of WETH supplied which can causes a liquidation in case of a price decrease.

With a proportional increase of market size by 10x and a decrease of (ETH) price decrease by 40%, there is only $40k of liquidations at risk.

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Simulation - Capital at Risk

Aligned with liquidations at risk, there is currently close to zero risk of drained liquidity for liquidations of wallets with sDAI as their largest supply asset.

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Analysis (Portfolio Risk)

The chart below shows the potential portfolio-level losses (CaR) across different liquidity change and supply growth scenarios. With the default price shock values mentioned above, CaR varies from $17M at the current liquidity and supply levels and could rise to $330M in case of a 40% decrease in liquidity and a 10x increase in supply.

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Additionally, we can move beyond the default price shock level for depeg risk (20%) and iterate over different price shock values. The chart below shows that the difference in the potential CaR between a 15% depeg and a 30% depeg is more than 10x ($1.1M vs. $14M). The simulated depeg risk comes solely from wstETH:WETH pair, rETH recursive exposure is still too low to pose meaningful economic risk.

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Additionally, we can iterate over the general market shock (volatile:stable asset pairs) and notice similar non-linear sensitivity of Capital at Risk to price shocks and supply growth. At the current level, $4.3M could potentially be at risk.

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Conclusion

Since our team's inception, we have used methodological transparency as a positive movement toward increasing the robustness of the DeFi lending space.

The model presented above shows a starting point from which we can continuously adjust the methodology as necessary. The simulated market shocks are beyond anything that we've seen in the past, meant to test the protocol's robustness against highly conservative scenarios.

The CaR at the chosen default price shocks (40% for volatile asset shocks, 20% for LST depeg shocks) shows a potential $17M bad debt incurred by the protocol at the current supply levels. It's crucial to reiterate that this is not a likely loss, more of a guidance given a certain market shock, meant to also open the question of both what kind of shocks the protocol needs to be protected against and also what kind of losses would still have a minimal impact on SparkLend's long-term prospects. Both of these questions can further inform the setting of risk parameters to further optimize the protocol's growth and junior capital requirement for AllocatorDAOs exposure towards Spark.