Sentiment

The Universal Margin Protocol

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Abstract

Traditional Finance (TradFi) has robust credit markets supported by massive tech infrastructure, insurance and derivative mechanisms. Additional data collection and reputation standards help mitigate credit risk by disincentivizing borrowers from default via possible impact to their credit score affecting future borrowing capacity. Together, this has allowed for the expansive growth of under collateralized lending in TradFi over the years. While disintermediation has been one of DeFi's strengths, it has prevented building similar primitives for an under collateralized credit market. In this paper we discuss *Sentiment*, a protocol that implements on-chain hypothecation to facilitate under-collateralized lending in a decentralised ecosystem. Sentiment allows borrowers to access under collateralized credit lines and mitigates credit risk for lenders by withholding the first right of ownership to any asset purchased by the borrowers' debt.

1 Introduction

Lending is one of the leading ways to gain yield on stablecoins and other crypto-assets today. The three main collateralized-debt protocols Aave, Compound and Maker have an aggregate TVL greater than $40B as of today. Nonetheless, all lending and borrowing in DeFi is relatively capital inefficient since it requires borrowers to overcollateralize their debt positions. This overcollateralization mitigates the inherent credit risk associated with any lending market. In TradFi, this risk is mitigated through credit reputation mechanisms and instruments such as insurance or credit default swaps that trade this risk. While these may exist in DeFi in the future, we currently lack this infrastructure that relies on objective data accompanied with enforceable credit and reputation systems at the foundational layer. We believe one way to increase capital efficiency and mitigate default risk for lenders, is by implementing hypothecation as the base for credit markets. Hypothecation in TradFi exists in two major forms today —

- Lenders hold the right to rescind or revoke ownership from assets that are pledged to secure a loan under certain conditions. This is seen in individuals taking on debt in the form of a mortgage or to buy a car.

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- Borrowers pledge margin (collateral) to secure a portion of the loan, and use the loan for further purchases. This is equivalent to a fund manager using margin or leverage to avail liquidity for an investment or trading opportunity.

In both scenarios the lender's credit risk is mitigated by their ownership to an asset pledged as collateral or the first right to ownership to any assets purchased with loaned assets. We believe that adapting hypothecation to lending and borrowing in DeFi will optimize capital efficiency without the need for heaps of credit infrastructure and intermediation as in TradFi.

The next section provides a component-wise description of the protocol and its function. This is followed by a closer look at the Risk Engine that maintains protocol health through margin calls and liquidations. Finally, we list some potential primitives that could be built upon by Sentiment along with future enhancements that could strengthen the protocol. Additionally the Appendix uses simple examples to outline the process flows undertaken by different actors interacting with the protocol.

2 Protocol

Sentiment enables secure undercollateralized lending by implementing on-chain hypothecation. There are three main actors interacting with the protocol — the depositor, the borrower and the maintainer. The *depositor* wants to lend their assets with the objective of earning yield. The *borrower* deposits margin (collateral) into a borrow account and takes out a loan against it. Borrowers are obligated to repay this loan with interest. *Maintainers* are external actors that are incentivized to maintain protocol health by triggering margin calls and liquidations on high-risk debt positions.

2.1 Asset Reserves

There are two different types of containers that help the protocol function smoothly —

- Borrow Accounts (BA) - Dynamic and distributed asset reserves that hold a borrower's margin deposit and loaned assets that are transferred when a debt position is created. Each BA represents a single debt position. The borrower has delegated ownership over the BA as described in §2.5.
- Lending Pools (LP) - Pooled reserves of assets deposited by lenders. They hold deposited assets until they are deployed to a borrow account when a debt position is created. The LP also holds a reserve of assets belonging to the protocol that are accumulated based on the reserve factor described in §2.6.

2.2 Tokenization

Sentiment tokenizes both sides of the debt position by introducing two different kinds of tokens — `lTokens` (lend tokens) and `bTokens` (borrow tokens).

Depositors lending assets to the lending pool will receive `lTokens` that serve as a receipt for their deposit. These `lTokens` are also used to claim liquidity and pro-rata interest accrued on the deposit. `lTokens` are composable and transferable tokens adhering to the ERC20 standard [VB]. They are minted upon every deposit and burned when liquidity is withdrawn. Users that lend assets receive `lTokens` which are equivalent to their principal balance plus any accrued interest. The exchange rate between the `lTokens` and the underlying asset increases over time as interest is accrued. This mechanism is inspired by Compound's `cTokens` [Fin].

The exchange rate E_x for `lTokens` associated with underlying token x at any point in time is determined by —

$$E_x = \frac{B_x + D_x - R_x}{L_x} \tag{1}$$

where,
B_x - Underlying balance of `lTokens` associated with x
D_x - Total debt (borrows) for `lTokens` associated with x
R_x - Amount of `lTokens` associated with x in reserves
L_x - Circulating supply of `lTokens` associated with x

The borrower's debt position will be tokenized using `bTokens` adhering to the ERC721 standard [Ent+]. This gives the holder delegated ownership to the associated margin vault and allows for credit delegation due to the transferable nature of these tokens.

2.3 Margin

The key risk for any form of undercollateralized lending in a decentralized, permissionless ecosystem is credit risk. The protocol implements the following measures to help mitigate that risk —

- Delegated Ownership - The borrower never has custody of the loaned assets i.e they cannot be transferred out of the margin vault. This delegated ownership model allows the borrower to have control over how the funds are deployed without having custody, thus passing the first right of ownership over these assets to the protocol.
- Controlled Interaction - The protocol restricts the actions a borrower can perform with the loaned assets to mitigate credit risk and maintain solvency. The allow-list for these set of actions is configurable and can be modified through governance mechanisms over time. The protocol can control what contracts (and by extension tokens) the borrowed assets are allowed to interact with.

2.4 Borrow Account Ownership

The Borrow Account will be implemented as a modified ds-proxy [Dap] that will maintain control and custody of borrower's margin (collateral), lender's credit (loan) and any other assets acquired during the term of debt. The control flow of the Borrow Account can be described as follows —

1. Borrower pledges margin (collateral) to borrow assets.
2. Lending pool initiates credit transaction, sending assets to the Borrow Account.
3. Borrower deploys the loaned assets in a controlled manner with the help of the `Interaction Controller` (§2.5).
4. The Risk Engine (§3) ensures health of the borrow account during the term of the debt.

During the term of a loan, all assets within the borrow account are controlled by the protocol and at no point will the borrower be able to actually obtain custody of credited funds. The only situation where a borrower would withdraw any assets from the vault is during termination or reduction of the debt position. The interest accrued on a position is always deducted from the margin pledged by the borrower. The protocol holds the first right to ownership on any assets in the borrow accounts. This right is exercised in the case of margin calls (§3.1) and liquidations (§3.2) when the overall position of a borrow account is reduced in order to manage solvency and risk. That being said, these scenarios are atypical and form the exceptional flows for the protocol.

2.5 Borrower's Abilities

Once a borrower opens a credit position, they have the ability to perform delegated actions on the loaned assets in their borrow account. All borrow accounts will have the same actionable events such as purchasing assets, providing liquidity, etc. This behavior can change in the future, with the introduction of tiered vaults with different sets of permitted actions. An initial set of allowed actions will be set which can be modified through governance mechanisms. Delegated actions will be controlled by the `Interaction Controller` — once a borrower takes out a loan, they will be able to send instructions (for trades, liquidity provisions, etc.) to the `Interaction Controller`. These instructions will be verified against the allow-lists, and if permissible, they will be executed on the borrowed assets. This implementation gives the borrower the ability to determine the use of the proceeds, benefits from the increase in value or profit of the funds while also protecting the lender from any default risk.

2.6 Interest Rate

The protocol implements floating interest rates in a manner that allows for easy configuration. These interest rate models are subject to modification and change in future versions of the protocol. Accrued interest is modelled as a function of *utilization* (i.e. demand for protocol reserves). The effective interest rate is the borrow rate, or the rate that borrowers pay for their loan. We employ a non-linear interest rate model, inspired from dYdX's lending markets [Cd]. The borrow rate for a given market can be determined using the relation —

$$I_b(t) = \Big((0.1 \cdot U(t)) + (0.1 \cdot U^{32}(t)) + (0.3 \cdot U^{64}(t))\Big) \cdot 3.5 \tag{2}$$

where,
$I_b(t)$ - Borrow Interest Rate for time t ($0 \leq I_b \leq 1.75$)
$U(t)$ - Utilization of funds at time t ($0 \leq U \leq 1$)

The lending rate, which denotes the yield for lenders, is computed using the borrow rate and the reserve factor R_f. The reserve factor represents the spread between the borrowing rate and lending rate. It will be used to increase protocol solvency and form the fees of the protocol that form the governance-controlled treasury. Initially, the reserve factor will be set at 5% but this is subject to change as per governance in the future. The lending rate can be computed as —

$$I_l(t) = R_f \cdot I_b(t) \cdot U(t) \tag{3}$$

where,
$I_l(t)$ - Lending rate at time t
R_f - Reserve factor
$I_b(t)$ - Borrowing rate at time t
$U(t)$ - Utilisation of funds at time t

3 Risk Engine

The health of a position is linked to the ability of the borrower to repay the loan. The objective of the risk engine is to maintain overall protocol health and mitigate the depositors' credit risk by managing at-risk debt. In addition to the risk of default, the protocol also accounts for volatility risk arising from sudden price changes in the borrowed (or collateral) assets which can put a position at risk. We define the risk factor $R(t)$ for a debt position at time t as below —

$$R(t) = \frac{\Big(A(t_0) + I(t)\Big) - A(t)}{L_d \cdot M(t)} \tag{4}$$

where,
t_0 - block timestamp when the debt position was created
$A(t)$ - Value of assets in the borrow account at time t
$I(t)$ - Cumulative interest accrued at time t
L_d - liquidation discount, $0 < d < 1$
$M(t)$ - Value of collateral pledged by the borrower at time t

Intuitively, the risk factor represents the fraction of the collateral that must be sold at a discounted rate to cover all losses incurred by the borrower and close the position.

3.1 Margin Calls

As described above (§2.1), lenders deposit and withdraw assets from the Lending Pool (LP) which is isolated from the Borrow Account (BA), where assets are held when deployed as part of a loan. To facilitate easy withdrawal and manage solvency, the protocol maintains a part of the funds as a floating reserve in the LP at all times. Even then, there could arise a situation where a large-ticket lender wishes to withdraw their assets and there aren't enough funds present in the LP as reserves. This presents the protocol with a dilemma — does it restrict the lender from withdrawing their own funds or does it forcibly terminate (possibly healthy) borrower debt positions? To address the issue, we implement a margin call mechanism based on debt health. We define two governance-controlled parameters —

- U' - Optimal utilization threshold
- M' - Margin call risk threshold

Any open position with $R(t) > M'$ (i.e. with risk factor higher than the margin call risk threshold) is deemed eligible to be margin called when $U(t) > U'$ (i.e LP utilization is beyond the optimal utilization threshold). For example, a value of $M' = 0.7$ implies that any position where the loss exceeds 70% value of the collateral put up by the borrower is eligible to be margin called if the LP does not have enough reserves, as indicated by its utilization metrics.

Here we also introduce *maintainers*, external actors that are incentivized to help maintain the LP float. In case a position is eligible to margin called, the maintainer can trigger this call and buy part of the collateral at a discount, so as to push the overall position risk below M'. Thus we create a mechanism that incentivizes external actors to help maintain protocol solvency by creating a risk-free arbitrage.

3.2 Liquidation

If the losses incurred by a borrower cannot be covered by the initially pledged collateral, there is a high chance of the borrower defaulting and losses being passed onto the lenders. This condition forms the basis of which the protocol decides to liquidate positions. When a loan is considered at risk it can be liquidated by an external actor (also called maintainer). We incentivize maintainers to liquidate a position by creating a risk-free arbitrage where they can buy the collateral assets at a discount to the market rate and help close out the position.

To this effect we define a governance-controlled value L' which defines the liquidation risk threshold for the protocol. Positions with $R(t) > L'$ (i.e. risk factor higher than the threshold) are deemed eligible for liquidations which can be triggered by a maintainer. The maintainer buys a fraction $R(t)$ of the collateral to help close out the position. The remaining $1 - R(t)$ is sent to the treasury as a liquidation fee.

4 Governance

Governance plays an important role in the long-term functioning of the protocol. Its role can be distilled to two main objectives, to help the protocol grow and to manage its risk appetite. The primary way these roles are exercised is by controlling different parameters that form key levels for the protocol. We provide a consolidated list of these parameters below —

- The allow-list for the `Interaction Controller`
- A block-list for addresses that should not be allowed to borrow from the protocol
- L' - Liquidation risk threshold
- M' - Margin call risk threshold
- U' - Optimal utilization threshold
- R_f - Reserve factor
- L_d - Liquidation discount
- L_{max} - Maximum borrowing leverage

5 Potential Applications

- Leveraged tokens (e.g. 3x long or 3x short)
- Protocol-to-protocol lending, protocol to consumer under-collateralized lending, protocol underwriting debt (i.e. Protocol A can extend margin for Protocol B, on its own behalf)
- Leverage-based yield strategies (e.g. delta neutral farming, delta neutral LP, hedge against IL)
- Leverage based primitives — Synthetic index funds, VIXY-like instruments, other option / derivatives
- Primitives built by fractionalizing the `bToken`
- On-chain Re-hypothecation

6 Future Enhancements

- Stable rate lending and borrowing using improved interest models
- Tiered Borrow Accounts — Different BAs can have different permissions. This could be a way to implement an on-chain reputation mechanism. e.g. if an EOA/contract has consistently repaid positions and never been liquidated, they could be eligible for an *account upgrade* which would allow them to perform different (riskier) actions or borrow with a higher leverage, etc.

- Soft-Liquidations — In a scenario where a borrower vault is in jeopardy of a liquidation, the protocol will increasingly *margin call* and decrease their loaned amount significantly until their loan is healthy. This helps optimize capital preservation. It returns capital (with interest) to the lender vault and optimizes the borrower's UX, where they are not decimated by liquidations. Consider a user who borrows $500k with $50k margin, with their position going against them, maintainers will seek to decrease their borrowed amount to $400k (returning $100k to the lender vault + interest) , rather than liquidating their entire position.

References

[Cd] Brendan Chou and dYdX. *How do Interest Rates Work?* URL: `https://help.dydx.exchange/en/articles/2924246-how-do-interest-rates-work`.

[Dap] DappHub. *DSProxy.* URL: `https://github.com/dapphub/ds-proxy`.

[Ent+] William Entriken et al. *EIP-721: Non-Fungible Token Standard.* URL: `https://eips.ethereum.org/EIPS/eip-721`.

[Fin] Compound Finance. *cTokens.* URL: `https://compound.finance/docs/ctokens`.

[VB] Fabian Vogelsteller and Vitalik Buterin. *EIP-20: Token Standard.* URL: `https://eips.ethereum.org/EIPS/eip-20`.

A Process Flow

A.1 Depositor

The depositor wishes to lend assets to the protocol. They can do so by providing assets to the Lending Pool (LP). Consider a depositor Alice - who wishes to lend tokens to the protocol. Alice deposits 1 ETH to the LP and receives a certain amount 0.85 lETH interest-bearing tokens as a receipt of their deposit. In the future when Alice wishes to withdraw their liquidity, they can exchange 0.85 lETH for 1.15 ETH representing their initial deposit and accrued interest over time.

A.2 Borrower

The borrower wishes to create a leveraged debt position using the protocol. Consider a borrower Bob, who pledges 2 ETH as collateral to create a debt position worth 5 ETH. Bob deposits their collateral to the borrow account (BA) and receives associated bTokens that allow them to perform delegated operations on the borrow account. The protocol adds the borrowed assets worth 5 ETH from the LP to the BA controlled by Bob. Let us consider the different scenarios that could develop during the term of Bob's loan.

In the first scenario, Bob makes some prescient bets that pay off handsomely. The value of borrowed assets in Bob's BA has grown from 5 ETH to 8.5 ETH. In the meantime, the position has accrued an interest of 0.2 ETH. Bob decides to close out their debt position with the protocol and initiates this process by redeeming their bTokens. The protocol returns 5 ETH back to the LP and transfers the rest of the assets (3.5 ETH worth of profits) back to Bob's account. The protocol then returns Bob's collateral after deducting the 0.2 ETH interest due on their debt. Accordingly Bob gets back 1.8 ETH from the initially pledged collateral.

In the second scenario, Bob doesn't fare as well and has incurred a loss on their debt. The value of the borrowed assets in Bob's BA has fallen from 5 ETH to 4.20 ETH. Moreover, the debt has once again accrued an interest of 0.2 ETH over this duration. Assume that this is followed by a surge of usage in the protocol which leads to high utilization of LP assets. Due to the increase in utilization coupled with the losses incurred (leading to higher position risk factor), the protocol margin calls Bob's position and lowers its risk factor by reducing Bob's position size. In this hypothetical scenario, a maintainer margin calls Bob and reduces their debt position to 3 ETH to push down the risk-factor of the position below the margin risk threshold.

In the final scenario, Bob has fared even worse. The value of 5 ETH worth of borrowed assets has fallen to 3.3 ETH. As earlier, the position has accrued an interest worth 0.2 ETH. This deems his position eligible to be liquidated. A maintainer triggers this liquidation and buys a portion of the 2 ETH pledged by Bob (at a discount) so that the protocol can recover the loss. The loaned asset values including interest (5.2 ETH) is sent back to the LP. The remaining fraction of the collateral is collected by the protocol as a liquidation fee.

A.3 Maintainer

Margin Calls - The maintainer continuously polls asset utilization and position risk-factors across the protocol. A maintainer can trigger a margin-call on any position where they see a risk-factor higher than the margin risk threshold coupled with utilization values exceeding the optimal utilization threshold.

Liquidations - The maintainer continuously polls position risk-health looking for positions with a risk-factor than the liquidation threshold. Any position with a higher risk-factor is deemed to be eligible for liquidation and accordingly a maintainer can trigger this process.