t3 - AI-Facilitated Under-Collateralized DeFi Lending

Technical Whitepaper v1.3

Abstract

The DeFi lending market faces a critical limitation: the requirement for over-collateralization restricts capital efficiency and market participation. t3 introduces a novel solution utilizing an AI-agent driven and facilitated risk management system that enables under-collateralized lending. By implementing modern portfolio theory and advanced statistical methods we create a more capital-efficient lending environment while maintaining robust risk controls. The t3 AI-agent, in turn, acts as a trusted intermediary and an abstraction layer between the on-chain lending ecosystem and the user. This approach has the potential to bridge the significant gap between traditional finance and DeFi, where currently DeFi lending represents merely 0.2% of the $10 trillion global lending market.

Contents

1 Risk Engine Framework

1.1 Theoretical Foundation

Our risk management system, the focus of our initial development phase, builds upon the established principles of modern portfolio theory while incorporating AI capabilities.

The risk engine employs multiple layers of analysis:

- Multi-factor risk assessment that considers market conditions, asset correlations, and historical patterns
- Real-time portfolio value at risk (VaR) calculations using high-frequency market data
- A variety of methods such as PCA for detecting hidden systemic risks
- Efficient frontier optimization for optimal evaluation of risks

By leveraging these components and utilizing an AI agent as an intermediary, t3 can offer lending terms that more accurately reflect the true risk of positions while requiring less collateral than traditional DeFi protocols.

1.2 Portfolio Risk Assessment

Our system implements a multi-dimensional approach to risk assessment that goes beyond simple metrics. The portfolio variance calculation incorporates both direct and indirect relationships between assets:

1.2.1 Portfolio Variance - initial blueprint

$$\sigma_p^2 = \sum_i \sum_j w_i w_j \rho_{ij} \sigma_i \sigma_j \tag{1}$$

This formula captures the risk profile of a portfolio by considering:

- Asset weights (w_i, w_j): The proportion of each asset in the portfolio
- Correlation coefficients (ρ_{ij}): How assets move in relation to each other
- Individual asset volatilities (σ_i, σ_j): The historical price volatility of each asset

The correlation coefficients are particularly important as they help identify opportunities for risk reduction through diversification. The correlations are continuously updated based on market conditions.

1.2.2 Efficient Frontier Construction

$$E(R_p) = \sum(w_i \times E(R_i)) \tag{2}$$

The efficient frontier represents the set of optimal portfolios that offer the highest expected return for a defined level of risk. t3 agent dynamically adjusts portfolio positions to maintain proximity to this frontier, ensuring capital efficiency while managing risk.

2 Margin of Safety Calculation

2.1 Confidence Interval Methodology

To enhance risk assessment, our system employs a prediction interval approach for calculating margins of safety. This method provides a more adaptive and precise evaluation of portfolio risk compared to traditional fixed margin requirements.

$$y_0 \pm t_{(n-p)}\left(\frac{\alpha}{2}\right) \cdot \sigma\sqrt{1 + x_0^T (X^T X)^{-1} x_0} \tag{3}$$

- y_0: The estimated portfolio value based on current market conditions.
- $t_{(n-p)}(\alpha/2)$: The critical value from the t-distribution, determined by the confidence level α and degrees of freedom $(n-p)$.
- σ: The standard deviation of the prediction error, capturing portfolio risk.
- x_0: The feature vector representing relevant portfolio characteristics.
- X: The historical data matrix used for regression-based risk estimation.
- $(X^T X)^{-1}$: The inverse covariance matrix, incorporating relationships between market variables.

This prediction interval approach allows us to:

- **Quantify** expected portfolio value fluctuations with statistical confidence.
- **Dynamically adjust** margin requirements in response to market conditions.
- **Incorporate market structure**, accounting for correlations and systemic risks.
- **Improve risk assessments** beyond traditional static models.

By leveraging this method, our system enhances capital efficiency while maintaining robust risk management, particularly in volatile crypto markets where asset correlations can shift rapidly.

2.2 Dynamic Risk Thresholds

Our system implements dynamic risk thresholds that adapt to changing market conditions:

$$\theta = \text{base\_threshold} \times (1 - \beta \times \sigma_{\text{market}}) \times (1 + \delta \times \text{div\_factor}) \tag{4}$$

This adaptive threshold considers:

- Market volatility (σ_{market}): Increases protection during volatile periods
- Portfolio diversification (div_factor): Rewards diversified positions
- Market sensitivity (β): Adjusts based on correlation with broader market movements

The dynamic nature of these thresholds allows us to offer more favorable terms during stable market conditions while automatically increasing protection during periods of market stress.

3 Under-collateralized Lending Mechanism

The foundation of our innovation lies in its unique approach to collateral management and risk assessment. Through our User Account Wallet (UAW) system, we've created a flexible yet secure framework that enables lending with significantly lower collateral requirements than traditional DeFi protocols.

3.1 Collateral Management Through UAW

The User Account Wallet provides a trusted and flexible environment for asset management. Each user receives a dedicated UAW that operates under strict access controls, with interactions limited exclusively to the originating wallet address. This design ensures security while maintaining user autonomy over their assets.

Within the UAW, collateral management follows the fundamental equation:

$$\text{NLV} > \text{Loan Amount} + \text{Safety Margin} \tag{5}$$

This equation represents our core safety principle, where the Net Liquidation Value (NLV) must always exceed the loan amount plus a safety margin. The safety margin is dynamically calculated based on market conditions and portfolio composition.

The user is able to maintain as little as 10% collateral vs loan value and can instruct / invest the full sum of the collateral and the loan. This approach dramatically improves capital efficiency for the user/borrower while maintaining robust risk controls through continuous monitoring and assessment.

3.2 Portfolio Health Assessment

Our portfolio health monitoring goes beyond simple collateral ratios - our system implements a sophisticated health metric that considers multiple factors:

$$H = (P_v(1 - h))/L \tag{6}$$

The health factor H provides a comprehensive view of portfolio stability by incorporating:

- Portfolio Value (P_v): The current market value of all assets within the UAW
- Haircut Factor (h): A dynamic risk adjustment
- Loan Amount (L): The total outstanding borrowed value

The haircut factor h is adjusting in real-time based on:

1. Historical volatility patterns of held assets
2. Current market liquidity conditions
3. Cross-asset correlation metrics
4. Overall market stress indicators

4 Risk Mitigation Framework

Effective risk management is critical in under-collateralized lending, where market volatility and borrower behavior can significantly impact protocol stability. Our framework employs multi-layered risk assessment and dynamic adjustments, ensuring that risk is proactively managed at both the position and portfolio levels.

4.1 Position Risk Assessment

Each lending position contributes differently to overall portfolio risk. To quantify this, we use the position risk contribution formula:

$$RC_i = w_i \times \frac{(\sigma_i \times \beta_i)}{\sigma_p} \tag{7}$$

Where:

- RC_i = Risk contribution of position i.
- w_i = Weight of asset i in the portfolio.
- σ_i = Volatility of asset i.

- β_i = Sensitivity of asset i to the overall market.
- σ_p = Total portfolio volatility.

This formula helps determine how much each position increases/reduces overall risk, allowing the system to rebalance portfolios dynamically.

Additionally, the t3 AI agent continuously evaluates:

- **Market Impact:** Ensuring that liquidation of large positions does not disrupt overall market stability.
- **Correlation Effects:** Identifying diversification opportunities and risk concentration issues.
- **Volatility Patterns:** Updating asset risk profiles based on historical and implied volatility metrics.

4.2 Dynamic Risk Adjustment

Rather than using static risk parameters, our system dynamically adjusts risk factors based on market conditions. The dynamic risk adjustment formula is:

$$R_{adj} = R_{base} \times \left(1 + \sum(\alpha_i \times F_i)\right) \tag{8}$$

- R_{adj} = Adjusted risk level
- R_{base} = Base risk threshold
- α_i = Weight assigned to risk factor i
- F_i = Market indicator or portfolio-specific factor affecting risk

This allows the agent to dynamically update risk settings in response to:

- **Market-Wide Factors:** Volatility indices, trading volumes, and liquidity shifts.
- **Portfolio-Specific Factors:** Asset concentration, correlation patterns, and historical performance.
- **Blockchain-Specific Conditions:** Network congestion, gas costs, and transaction risks.

5 Portfolio Optimization

At t3, we merge modern portfolio theory with AI-driven functionality, such that our system achieves optimal risk-adjusted returns while maintaining lending security.

5.1 Efficient Frontier Optimization

The mathematical foundation of our portfolio optimization strategy is expressed through the following optimization problem:

$$\begin{aligned} minimize: w^T \Sigma w \quad \text{subject to} \quad & \sum_i w_i = 1 \\ & w^T \mu = R_{target} \\ & w_i \geq 0 \end{aligned} \tag{9}$$

The AI agent continuously solves this optimization problem while considering real-world constraints and market conditions. The process incorporates transaction costs, market impact, and liquidity constraints to ensure that theoretical optimality translates into practical efficiency.

6 AI Agent Implementation

Our t3 AI agent is an multi-model system that integrates various language models (LLMs) and specialized machine learning frameworks to optimize risk assessment, lending operations, and portfolio management. The agent serves as an intelligent intermediary between users and the protocol (originally Jupiter exchange), providing analysis and decision-making capabilities. Additionally, it serves as an abstraction layer between the user and the many functionalities that would be necessary to allow for such an undercollateralised lending system. Finally, on-chain lending requires a high level of knowledge of the defi ecosystem, which is no longer the case under our protocol.

6.1 Hybrid On-Chain & Off-Chain AI Processing

- **Off-Chain Intelligence**: computations such as risk simulations, occur off-chain via secure, high-performance compute nodes.
- **On-Chain Execution**: smart contract automation ensures real-time enforcement of lending conditions, collateral adjustments, and liquidation thresholds.

7 Market Integration and Execution

Our system has been designed to interface with multiple market venues while maintaining execution efficiency and risk control throughout the trading process.

Our primary integration with Jupiter as a DEX partner provides the foundation for market access. This integration has been designed to ensure optimal price discovery and execution capabilities.

The execution optimization process takes into account multiple market factors to determine the best approach for each trade, such as order book level 1, 2, and 3 data. Rather than simply executing orders immediately, the system analyzes market conditions to determine optimal timing and size. For larger orders, the system aims to break down trades into smaller pieces, minimizing market impact.

8 System Security and Risk Controls

Security stands at the forefront of our design, with multiple layers of protection working together to ensure both user fund safety and system stability. The protocol's smart contract architecture incorporates safety mechanisms that can respond automatically to extreme market conditions. These circuit breakers operate based on multiple market indicators, providing protection against sudden market moves and longer-term adverse conditions.

Risk monitoring is a continuous process that examines risk at multiple levels simultaneously. At the portfolio level, individual risk metrics are constantly calculated and evaluated against predetermined thresholds. System-level monitoring tracks aggregate risk measures across all protocol participants, ensuring that systemic risks remain within acceptable bounds. Market-level monitoring provides context for risk assessments and helps identify potential market stress conditions before they impact portfolio stability.

9 Conclusion

The DeFi lending market is limited by the need for over-collateralization, making it inefficient and restricting participation. t3 addresses the issue with an AI-powered and facilitated risk management framework that enables under-collateralized lending while maintaining strong risk controls. By leveraging modern portfolio theory, real-time market data, and machine learning models, our protocol dynamically adjusts risk thresholds and optimizes lending terms. The integration of an AI agent allows it to act as a trusted intermediary, and an abstraction layer between the complex on-chain lending mechanisms and the user. We believe our approach is a major step forward in DeFi lending, bridging the gap between traditional finance and blockchain-based lending with a smarter, data-driven strategy.