Dederi - A Defi Derivatives Clearing and Settlement Protocol

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Abstract

Dederi is a suite of smart contracts built on the Ethereum network, designed to provide decentralized clearing and settlement services for derivatives (futures and options). It also supports structured position combinations (hereafter referred to as "strategies") involving up to eight arbitrary futures and options positions through portfolio margin trading.

The vision of Dederi is to become the foundational infrastructure and standard for on-chain derivative clearing and settlement, thereby advancing the development of the crypto derivatives sector. It aims to pave the way and offer support for a broader range of crypto derivative products and services in the future.

1 Introduction

Part 2 of this document analyzes the current composition of the crypto derivatives market, as well as the unmet needs, primarily explaining why we are establishing Dederi;

Part 3 introduces the rules for the issuance of derivatives and the clearing and settlement rules within Dederi, mainly detailing how we are constructing Dederi;

Part 4 presents some applications that have been developed based on the Dederi protocol and those that are under development, focusing on the strategies to bring Dederi to the market;

Part 5 looks forward to scenarios where the Dederi protocol can be developed and utilized by any individual or institution in the future;

In conclusion, Appendix A details the methods and examples for calculating the Dederi Index Price and Mark Price; Appendix B provides the methods and examples for calculating the composite margin of Dederi.

2 Options, Futures and Structured Products

2.1 Current State of Defi Derivatives

With the rise of Ethereum and the development of Defi, leading projects in the realm of crypto asset borrowing, such as Compound and AAVE, have come into existence. These initiatives have effectively satisfied the financial requirements associated with borrowing, laying the groundwork for the creation and growth of the Defi interest rate market.

In the spot trading domain, Uniswap revolutionized the space by solving the high costs and low efficiency of blockchain-based trade matching, offering an almost perfect alternative for on-chain price discovery of crypto assets. The exploration and development of leading projects like Uniswap and Curve laid the groundwork for the establishment and development of the Defi exchange rate market.

Once a foundation was established in both the interest rate and exchange rate markets, following the path of traditional financial markets, the derivatives market was poised for robust growth. As the crypto market matures, the proportion of professional and sophisticated traders among market participants, along with their trading volume, is expected to increase gradually, leading to a growing demand for various types of derivatives.

With the development of ETH layer 2 and other underlying blockchain technologies, we have indeed seen the emergence and growth of several derivatives platforms. However, due to the complexity of derivative transactions and the limitations of underlying blockchain performance, the development in this field has been significantly slower compared to the aforementioned areas:

- In the field of linear derivatives (futures), we have seen some promising products that are continuously optimizing to better meet user needs and have already captured a certain market share, such as DYDX and GMX.
- In the field of nonlinear derivatives (options and

related structured products), Defi projects have not made significant breakthroughs. The user experience and liquidity of existing projects are hardly sufficient to meet the market's demand for derivatives. The issuance, clearing, and settlement of derivatives also lack a universally accepted infrastructure that can be applied to the vast majority of scenarios.

2.2 Liquidity

As an emerging asset class, the cryptocurrency market's infrastructure remains underdeveloped, with participants of varying degrees of maturity and a strong speculative nature. This leads to rapid aggregation and dispersion of liquidity, resulting in significant market volatility. Additionally, there is a severe homogenization of crypto derivative products, with liquidity extremely concentrated in a few leading centralized exchanges, especially in the options market. Due to the high barriers to entry and fewer participants, liquidity shortages can severely impact normal price discovery and trading activities. Even under normal market conditions, it is challenging for options trading platforms to maintain order book depth across multiple contracts, with most liquidity concentrated in a few contracts such as monthly and quarterly options.

Therefore, we believe that establishing a set of over-the-counter (OTC) trading infrastructure for crypto derivatives, which utilizes a decentralized approach for the issuance, clearing, and settlement of derivatives, can help mitigate the systemic risks associated with centralized clearing.

2.3 Centralized Moral Hazard

In every traditional financial cycle, systemic risks of varying scales emerge, along with the exploitation of rule-followers by rule-makers. Similarly, in the cryptocurrency market cycles, each cycle witnesses the collapse and default of numerous centralized institutions, as well as instances where centralized entities, under external pressures, assist in freezing assets of one party involved in geopolitical conflicts. With the mainstreaming of crypto assets, such issues are likely to continue unabated, providing a fundamental advantage for the development of Decentralized Finance (Defi).

In summary, the market necessitates the establishment of a decentralized system for the issuance, clearing, and settlement of crypto derivatives that can be universally trusted and applied. On one hand, this fills a gap in the Defi world, offering a new alternative to the derivatives sector dominated by centralized clearing and settlement. On the other hand, it lays the foundation for future, more complex applications of crypto derivatives.

3 On-chain Issuance, Clearing, and Settlement

3.1 Dederi Account Logic and Issuance of Derivative Contracts:

When users connect their on-chain wallet addresses to Dederi, they can hold two types of assets within the corresponding Dederi smart contracts:

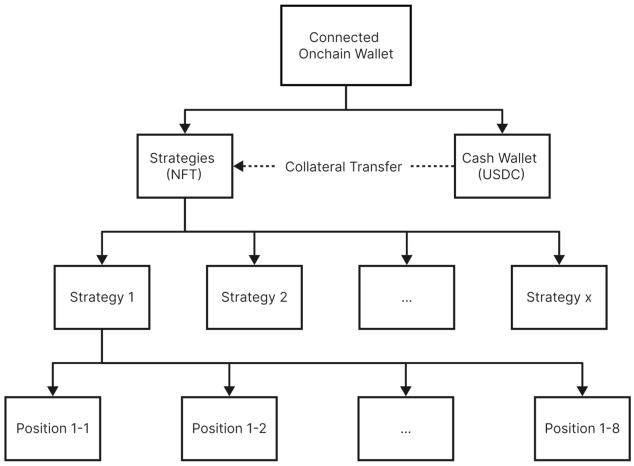

Figure 1: Dederi Account Logic

- Cash (USDC): Currently, all clearing and settlement processes within Dederi are conducted in USDC. Users must deposit USDC into Dederi contract (Cash Wallet) and can also withdraw USDC from the Cash Wallet to their own on-chain wallet address.
- Strategies (NFTs): Trading accounts within Dederi are defined as "strategies", with each strategy acting as a trading sub-account. Each strategy can hold up to eight different futures or options positions simultaneously. Each associated crypto wallet address can create multiple strategies, with the profits, losses, and risks of multiple strategies calculated independently. When each strategy is established, users need to transfer the required funds from their Cash Wallet balance to that strategy. The Dederi smart contract will issue an NFT corresponding to that strategy to the strategy holder. This NFT can be transferred by the holder to any other on-chain wallet address, and with it, the entire ownership rights of the strategy, including positions, profits, losses, and margin, will also be transferred. Moreover, the strategy NFT is destroyed upon its transfer.

Dederi enables anyone to issue options and futures derivative contracts based on two cryptocurrency underlyings: BTC and ETH. The issuance rules are as follows:

Contract Duration	1 to 24 weeks, with the 24th-week contract opening for settlement each week.
Settlement Time	Every Friday at 08:00 UTC
Settlement Price	30-minute TWAP before settled
Settlement Method	Cash settled
Settlement Currency	USDC
Contract Start Time	08:00 UTC

Table 1: The Rules for Futures Issurance

Additionally, the contract parameters are as follows:

Underlying	BTC Index	ETH Index
Symbol	BTC/ETH-29SEP23-Future	
Min Order Size	0.1	1
Price Quotation	1BTC	1ETH
Tick Size	1 USD	0.1 USD
Position Limit	10000BTC	100000ETH
Allowed Trading Bandwidth	$[TickSize, 2 \cdot I]$	$[TickSize, 2 \cdot I]$ [1]

Table 2: Parameters for Futures Contract

Underlying	BTC Index	ETH Index
Symbol	BTC/ETH-29SEP23-2800-C/P	
Exercise Style	European	
Strike	Multiples of 100 USD, within a range of 50% to 150% of the Index price.	
Min Order Size	0.1	1
Tick Size	1 USD	0.1 USD
Multiplier	1	1
Short Position Limit	10000BTC	100000ETH
Allowed Trading Bandwidth	C:$[max(F - K, TickSize), F]$ P:$[\max(K - F, TickSize), K]$	

Table 3: Parameters for option contract

3.2 Clearing and Settlement

3.2.1 Portfolio Margin

Dederi employs a portfolio margin system to significantly enhance traders' capital efficiency. The margin required for a single strategy is determined collectively by multiple positions within that strategy and is calculated in real-time.

When a strategy holds multiple positions that can offset each other, the required margin can be significantly lower than that in the Standard Margin mode. When establishing a new strategy or adding positions to an existing one, the required margin amount is the Initial Margin (IM). The minimum margin amount needed to maintain a strategy is the Maintenance Margin (MM). If a strategy's losses cause its equity to fall below the MM, it enters a state where it can be forcibly liquidated.

3.2.2 Liquidating

Dederi adopts a third-party liquidator model. Anyone can act as a liquidator and initiate liquidation for strategies in a liquidatable state. After verifying the status of the strategy to be liquidated, Dederi calculates a fair Liquidating Price [2]. If the liquidator agrees to this price, they will pay the required margin and acquire all positions of the liquidated strategy.

3.2.3 Auto-Deleveraging (ADL)

If a strategy in a state eligible for liquidation is not liquidated promptly, and its risk profile further deteriorates, ADL is triggered. The counterparties of all positions within the strategy subject to ADL will be reduced sequentially, based on the current Leverage PnL ratio from highest to lowest, until all positions within the strategy have been offset and closed.

3.3 Trading

The Dederi protocol does not facilitate price discovery, meaning it lacks a trade order book and matching engine. Anyone can directly utilize Dederi's derivative clearing and settlement services by invoking one or multiple contracts of Dederi.

Additionally, we have developed Dederi-RFQ, offering a set of over-the-counter (OTC) trade quoting tools to meet the demand for derivative OTC trading and attract market makers to provide liquidity. Furthermore, we have developed Dederi-Builder, a graphical strategy (structured product) construction tool to assist users in more easily building structured products or strategy combinations. These two tool applications will be introduced in detail later in the text.

4 Builder, RFQ, AMM

4.1 Dederi-RFQ: Request for Quotation Platform Tool

Utilizing the Dederi protocol through direct calls to on-chain contracts can be user-unfriendly for many potential users. Therefore, we developed the first application based on the Dederi protocol, a derivative over-the-counter (OTC) trading request for quotation tool: Dederi-RFQ. The functions provided by Dederi-RFQ

[1] The algorithm for Index Price and Mark Price are detailed in Appendix A.1 & A.2

[2] The algorithm for the Liquidating Price is detailed in Appendix A.2.4.

include:

- Strategy construction, including individual position building and importing commonly used strategy templates.
- initiate requests for quotes, including for opening and closing positions, with options to create new strategies or merge into existing ones.
- Filter and responding to others' requests for quotes, including creating new strategy quotes or merging them into existing strategies.
- Split positions within a single strategy into multiple strategies.
- Merge positions within multiple strategies into a single strategy.
- Adjust strategy margins.
- Display trading and risk parameters.
- Request quotes for closing positions.

With these features, any user unfamiliar with on-chain contracts can connect their Ethereum wallet and simply trade using the Dederi-RFQ graphical interface. For professional traders, the RFQ tool offers opportunities for OTC market making. For ordinary traders, Dederi-RFQ provides the most comprehensive and realistic trading needs derivative tool in the Defi domain. Anyone can easily construct derivative trading positions or strategies and achieve on-chain clearing and settlement. This offers the market an alternative to centralized exchanges. Dederi-RFQ is currently available in beta version.

4.2 Dederi-Builder: A Graphical Structured Tool Based on Expected Pay-Off

To simplify the strategy construction process for users, we have developed Dederi-Builder—a graphical position builder tool. Similar to other position builder tools, it can directly calculate and graphically display the overall Pay-Off of the added portfolio position. Additionally, Dederi-Builder allows for the direct adjustment of individual positions within the Pay-Off graph, further lowering the barrier to structuring. With minimal effort, any user can easily construct their own structured products. Dederi-Builder has been integrated into Dederi-RFQ.

4.3 AMM Pool

We are in the process of developing an automated market-making pool to automate quoting for requests for quotations or liquidation strategies within Dederi-RFQ. By leveraging Dederi's MarkPrice algorithm for pricing futures basis and options volatility, along with adjustments based on the market-making pool's Greeks risk, liquidity will be provided within the pool's capacity limits for all trading requests on the Dederi protocol.

This market-making pool must reconcile the contradiction between the returns for liquidity providers (LPs) and the competitiveness of guaranteed quotes, requiring extensive calculations and testing. It will be launched once adequately tested and validated.

5 The Future Ecosystem of Dederi

As Dederi establishes and perfects the decentralized infrastructure for the issuance, clearing, and settlement of derivative contracts, there is potential to cultivate a comprehensive derivatives trading ecosystem. This includes:

- Decentralized Derivatives Exchanges: The creation of derivatives exchanges that leverage Dederi's clearing and settlement systems, focusing on Dederi-issued strategies (NFTs) as tradeable assets. This initiative is designed to draw liquidity, ensuring more robust and equitable derivatives pricing.
- Decentralized Asset Management: Utilizing Dederi strategies directly for the fund-raising, execution, distribution, and liquidation of passive asset management offerings, such as options-based structured products, ensures that the entire process is transparent and decentralized from start to finish.
- Expansion to Additional Underlying Assets: In addition to BTC and ETH, Dederi plans to effortlessly extend its support to a wider array of assets, including Altcoins, indices, and interest rates, further diversifying its offerings.

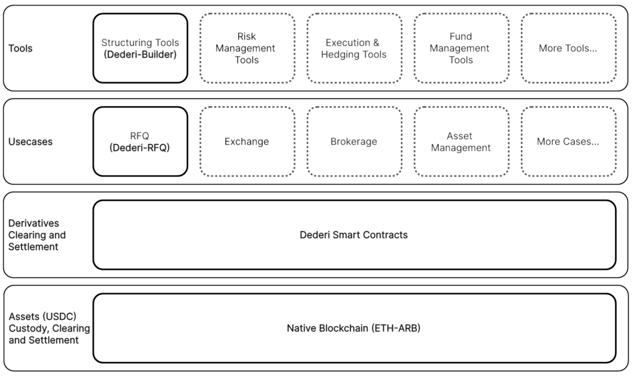

Figure 2: The Future Ecosystem of Dederi

The establishment of the ecosystem requires the participation of many. Anyone or any institution can use Dederi as a foundation to develop the aforementioned applications or others not mentioned. The Dederi team will continue to provide technical support.

Additionally, Dederi plans to launch the Dederi Token in the near future to further incentivize contributors to the ecosystem, including traders and builders.

Appendix A Index Price & Mark Price Methodology

A.1 Index Price

In Dederi, the index-prices for BTC and ETH are meticulously computed and verified using the most recent spot prices from a selection of five exchanges, namely Bitstamp, Gemini, Bitfinex, Coinbase, and Binance. Should there be a delay exceeding three minutes in the order book data from any exchange, that exchange data is then omitted, with the index-price recalculated using data from the other exchanges. Essentially, the index-price updates every second and the computation involves two key steps:

A.1.1 Computation of index-price

Determine the mid-price P:

$$P = \frac{Bid + Ask}{2} \tag{1}$$

Calculate $BenchmarkPrice$:

$$BenchmarkPrice = \text{median}(P_1, P_2, \ldots, P_n) \tag{2}$$

Limit prices within a +/-0.5% range of benchmark-price and get the adjusted price $\tilde{P}_k$:

$$\tilde{P}_k = \text{clamp}\left(P_k, BenchmarkPrice \cdot 99.5\%, BenchmarkPrice \cdot 100.5\%\right) \tag{3}$$

Apply equal-weighted average algorithm and derive the index-price:

$$IndexPrice = \frac{1}{n}\sum_{k=1}^{n} \tilde{P}_k \tag{4}$$

A.1.2 On-Chain Price Cross-Verification

The index-price obtained in step 1 should further undergo a cross-verification process against the prices fed by Chainlink and Uniswap:

$$\min\left(\frac{|IndexPrice - P_{\text{Chainlink}}|}{IndexPrice}, \frac{|IndexPrice - P_{\text{Uniswap}}|}{IndexPrice}\right) \leq MaxIndexDiscrepancy \tag{5}$$

If at least one set of comparisons has a discrepancy within the range of $MaxIndexDiscrepancy(MID)$, the calculated $IndexPrice$ is deemed valid and is utilized; conversely, an anomaly is flagged and the $IndexPrice$ is adjusted to:
$\min(LastIndexPrice \cdot (1 + MID), MedianPrice)$,
if $LastIndexPrice < MedianPrice$;
$\max(LastIndexPrice \cdot (1 - MID), MedianPrice)$,
if $LastIndexPrice > MedianPrice$.

where $LastIndexPrice$ refers to the $IndexPrice$ most recently published, and the formula for $MedianPrice$ is as follows:

$$\text{median}\left\{Index, ChainlinkPrice, UniswapPrice\right\} \tag{6}$$

Example 1: As of 3:22 PM on January 9th, 2024, we have gathered market data from five exchanges. The previous index was valued at 46,212.56. Prices fed from ChainLink and UniSwap are 46,725.12 and 46,334.29. The Dederi index price algorithm is as follows:

Price/Exchange	Bitstamp	Gemini	Bitfinex	Coinbase	Binance
Ask	46869.52	46873.84	46849	46862.39	46838.09
Bid	46869.21	46867.88	46848	46860.61	46838.08
P	46869.37	46870.86	46849	46861.50	46838.09
Benchmark Price	46861.50				
Adjusted Price	46869.37	46870.86	46849	46861.50	46838.09
Unverified Index	46857.66				
Cross Verification	(Index - ChainLink) / Index = 0.28% (within range) (Index - UniSwap) / Index = 1.12% (out of range) The index discrepancy with ChainLink is within 1%, the unverified index price passes the verification				
Dederi Index	46857.66				

A.2 Mark Price

Mark-price represents a fair estimated value for futures and option pricing, employed for the purposes of risk management and settlement. An equitable mark-price is one of the essential elements for calculating margin. This value is continuously updated in response to market fluctuations to better reflect the prevailing level of market risk.

A.2.1 Futures ABR & Mark Price

In accordance with futures pricing theory, the mark price of a future with maturity date T is defined as:

$$F_t = I_t \cdot e^{ABR(T)\cdot(T-t)} \tag{7}$$

where I_t is the index price for futures, t is the current time and ABR refers to the annualized basis rate for futures with maturity T.

We collect the latest price data $\left\{(T_i, F_t^{T_i})\right\}_{i=1,2,\ldots,n}$ for futures contracts with different maturities on Deribit, and from this, we calculate the respective annualized basis rates $ABR(T_i)$ with different maturities T_i:

$$ABR(T_i) = \frac{1}{T_i - t}\log\left(\frac{F_t^{T_i}}{S_t}\right) \tag{8}$$

where S_t corresponds to the index price of the underlying.

By interpolating these data, we can obtain the annualized basis rate ABR for futures contracts corresponding to any maturity T. ABR undergoes hourly updates.

A.2.2 Option Volatility and Volatility Surface

The valuation of option necessitates volatility as the most fundamental element. The Black-Scholes model assumes that asset prices follow a geometric Brownian motion with constant volatility. However, actual market volatility varies with the strike price and time to maturity. Fitting a volatility surface can better prevent strict arbitrage while exposing pricing biases, aiding market makers in adjusting quotes to reduce risk exposure.

We apply the Stochastic Volatility Inspired (SVI) model [1] to fit the implied volatility surface, utilizing real-time options data traded on exchange. Specifically, we initialize a set of parameters, denoted as $\chi_R = \{a, b, \rho, m, \sigma\}$. We assume that the total implied variance, ω, for options with strike price K, adheres to the following formula:

$$\omega(k; \chi_R) = a + b\left[\rho(k-m) + \sqrt{(k-m)^2 + \sigma^2}\right] \quad (9)$$

Simplified as $\omega(k)$, the implied volatility $IV(K,T)$ is defined as:

$$IV(K,T) = \sqrt{\frac{\omega(k)}{T-t}} \quad (10)$$

where t signifies the current time, with $k = log(K/F_t^T)$ transforming the strike price K into log-moneyness.

We collect implied volatility data of out-of-the-money options on Deribit for various strike prices K, captured as $\{(K_i, v_i)\}_{i=1,2,\ldots,n}$, while F_{T_i} is the corresponding underlying futures price:

$$k_i = log(K_i/F_t^T) \quad (11)$$

$$\omega(k_i) = v_i^2 \cdot (T-t) \quad (12)$$

We obtain the dataset $\{(k_i, \omega_i)\}_{i=1,2,\ldots,n}$. Subsequently, we apply the Quasi-Explicit method [2] for parameter transformation (dimension reduction) of the original SVI formula.

Define $u = \frac{k-m}{\sigma}$, the raw parameters are transformed into:

$$\omega(u) = a + b\sigma\left[\rho u + \sqrt{u^2+1}\right] \quad (13)$$

Define $c = b\sigma, d = \rho b\sigma$, we have:

$$\omega(u) = a + du + c\sqrt{u^2+1} \quad (14)$$

We fix a set of values for (m, σ), and solve for $\{a, c, d\}$ using the lease squares methold:

$$\min_{a,c,d\in D} \sum_{i=1}^{n} \left(a + du_i + c\sqrt{1+u_i^2} - \omega_i\right)^2 \quad (15)$$

where D is the solution domain:

$$\begin{cases} 0 \le c \le 4\sigma \\ |d| \le \min(c, 4\sigma - c) \\ 0 \le a \le \max_i \{\omega_i\} \end{cases} \quad (16)$$

The result obtained from formula (14) identifies the optimal parameter set (a^*, c^*, d^*) for a specified combination of (m, σ). Utilizing (c^*, d^*), the corresponding parameters (b^*, ρ^*) for the original SVI formula can be deduced.

Consequently, this allows for the refinement of the fitting problem into a dual-layer nested optimization problem, delineated as follows:

$$\min_{\sigma,m} \sum_{i=1}^{n} (\omega_{a^*,b^*,\rho^*,m,\sigma}(k_i) - \omega_i)^2 \quad (17)$$

Ultimately, by applying the optimal parameter set $\{a^*, b^*, \rho^*, m^*, \sigma^*\}$ to the calculation of the option's implied volatility and utilizing interpolation methods, we can obtain Deribit's calibrated volatility surface.

A.2.3 Option Mark Price

Ultimately, option prices are calculated using the Black model [3]. F_t represents the mark price of the underlying futures, and r denotes the risk-free rate:

$$c(K,T) = e^{-r(T-t)}[F_t N(d_1) - KN(d_2)] \quad (18)$$

$$p(K,T) = e^{-r(T-t)}[KN(-d_2) - F_t N(-d_1)] \quad (19)$$

where

$$d_1 = \frac{\ln(\frac{F_t}{K}) + (\frac{\sigma^2}{2})(T-t)}{\sigma\sqrt{T-t}} \quad (20)$$

$$d_2 = d_1 - \sigma\sqrt{T-t} \quad (21)$$

Example 2: Emma holds a BTC call option labeled BTC-10JAN24-43000-C. As of now, the underlying futures price $F_t = 42562.84$ and the option has 0.0195 years remaining until its expiration. Assume the current implied volatility is 0.353, calculate mark price for this option.

$$d_1 = \frac{\ln(\frac{42563}{43000}) + (\frac{0.353^2}{2})(0.0195)}{0.353\sqrt{0.0195}} = -0.1827$$

$$d_2 = -0.1827 - 0.353\sqrt{0.0195} = -0.2319$$

$$c(K,T) = 42563 \cdot 0.43 - 43000 \cdot 0.41 = 640.65$$

A.2.4 Liquidating Price

When the risk associated with any account trading on Dederi becomes excessively high, the account enters a state where it can be liquidated. At this point, a liquidator can take over the position at a recommended price (Liquidating Price).

To calculate the liquidating price, one must first ascertain the Smooth Mark Price (SMP) by conducting a Time-Weighted Average Price (TWAP) calculation based on the index price over 10-minute period. The Smooth Mark Prices for futures and options are denoted as $FSMP$ and $OSMP$, respectively.

Subsequently, we need to determine the Maintenance Margin Ratio ($MMRatio$) based on SMP. If this ratio exceeds 100%, the strategy enters into a liquidation-eligible state. The liquidating prices for futures and options are defined as $FLDP$ and $OLDP$, respectively:

$$FLDP = \begin{cases} FSMP/(1 + LongFLDF), Q_f > 0 \\ FSMP \cdot (1 + ShortFLDF), Q_f < 0 \end{cases} \tag{22}$$

$$OLDP = \begin{cases} OSMP/(1 + LongOLDF), Q_o > 0 \\ OSMP \cdot (1 + ShortOLDF), Q_o < 0 \end{cases} \tag{23}$$

Example 3: Jaz has devised a strategy that consists of 1 BTC-23FEB24-39800-C option short position (with a holding price of 1000) and 1 BTC-23FEB24 futures short position (with a holding price of 43100). The total margin for the current strategy is 20090.54, with an MM Ratio of 66.86%.

Suppose that on a day before the expiration date, the market experiences a significant rally driven by positive news for BTC. At a certain moment, within ten minutes, the smooth mark price for the option rises to 3000, and the smooth price for the future also increases to 45700. Jaz's strategy's MM Ratio exceeds 100%, entering a state eligible for liquidation.
Given that $Q_f < 0$ and $Q_o < 0$:

$$FSDP = 45700 \cdot (1 + 10\%) = 50270$$
$$OSDP = 3000 \cdot (1 + 15\%) = 3450$$

A.2.5 Parameters for Appendix A

Parameters[3]	**Value**
MaxIndexDiscrepancy	0.01
r	0
LongFLDF	0.1
ShortFLDF	0.1
LongOLDF	0.15
ShortOLDF	0.15

[3] Note: all parameters are subject to the latest values published on the Dederi official website

Appendix B Portfolio Margin Methodology

Dederi employs Portfolio Margin for strategy-level risk control. To accurately assess the maximum potential loss of the portfolio margin, we consider two key factors: a ±15% fluctuation range in futures prices and the maximum change in implied volatility, termed MaxIVChange. Building on this, we also take into account the potential impact of the size of futures or options positions on existing liquidity, introducing Futures Contingency and Option Contingency respectively. Upon these assessments, we determine the total margin requirements for the entire portfolio. It's crucial to highlight that all margin calculations at Dederi are valued in USDC.

B.1 Futures Maximum Loss and Futures Contingency

Assume the mark-price of futures i with expiration date T_i and $F_0^{T_i}$ and the contract size is Q_i. Given the range of price shocks, denoted by Δ_k, where Δ_k is one of the elements of set $\Omega(PriceShockRange)$. The futures simulated P&Ls ($FuturesSimPnL, FSimPnL$) is calculated as:

$$\begin{aligned} FSimPnL &= \sum_i [Q_i \left(F_0^{T_i}(1+\Delta_k)\right) - Q_i F_0^{T_i}] \\ &= \Delta_k \sum_i Q_i F_0^{T_i} \end{aligned} \tag{24}$$

The setting of Futures Contingency ($FContgy$) takes into account the potential negative impact of trading on market liquidity. This is particularly significant for traders with large positions, as their trades can cause notable liquidity shocks. By incorporating Futures Contingency into the margin calculation, we can effectively mitigate potential risks arising from liquidity changes caused by trading.

$$FContgy = FContgyFA \cdot I_0 \cdot \sum_{i=1}^{N} |Q_i| \tag{25}$$

Example 4: Alice has a long position in futures labelled ETH-12JAN24 with size $Q_1 = 10$. The current date is December 21, 2023, and her position will expire in 20 days, which is January 12, 2024. Assume the current index I_0 is priced at 2243.31 and ABR is 8%:

$$F_0 = 2243.31 \cdot e^{0.08 \cdot (\frac{20}{365})} = 2253.17$$

$$FContgy = 0.006 \cdot 2243.31 \cdot 10 = 134.60$$

FuturesSimPnL											
Price Shock	-15%	-12%	-9%	-6%	-3%	**0**	3%	6%	9%	12%	15%
P&L	-3380	-2704	-2028	-1352	-676	**0**	676	1352	2028	2704	3380

$$FutureMaxLoss = 3380$$

B.2 Option Maximum Loss and Option Contingency

B.2.1 Option Simulated P&L

Assume that current time is t and the strike price and expiration date for option i are K and T_i, with current mark-price of the underlying futures being $F_0^{T_i}$. A futures position with the range of +/- 15% price shock is denoted as:

$$F_k^{T_i} = (1+\Delta_k)F_0^{T_i} \tag{26}$$

Regarding implied volatility, we assess scenarios of 'up', 'same', and 'down'. $MaxIVChange$ for each scenario is derived by performing calculations tailored to these varied conditions:

$$MaxIVChange_{\text{up}} = (\frac{30}{T_{\text{days}}})^{VPower} \cdot UpFA \tag{27}$$

$$MaxIVChange_{\text{down}} = (\frac{30}{T_{\text{days}}})^{VPower} \cdot DownFA \tag{28}$$

Where $VPower$ is determined by the remaining days to expiration T_{days} $((T_i - t) \cdot 365 days)$. If T_{days} is over 30, then $VPower$ will be set to $LongTermVPower$; if T_{days} is less than 30, $VPower$ takes the value of $ShortTermVPower$.

Assume the current implied volatility of a certain option is σ_i, the implied volatility under three scenarios will be $\sigma_i^{down} = \sigma_i \left(1 - MaxIVChange_{down}\right)$, σ_i, $\sigma_i^{up} = \sigma_i \left(1 + MaxIVChange_{up}\right)$.

First, by incorporating the initial parameters $F_0^{T_i}, T_i, \sigma_i, K, r$ into the Black model, we can calculate the initial prices for two types of options (call/put) with different strike prices, based on the current market conditions. Subsequently, we sequentially input a range of different futures prices and volatilities into the Black model, thereby generating 33 distinct option prices ($11\Delta_k \cdot 3$ scenarios). In the final step, we subtract these prices from the initial prices of corresponding options with the same option type and strike price, to derive the option simulated profit and loss ($OptionSimPnL, OSimPnL$). The methodology is as follows:

$$\begin{aligned} OSimPnL_k^{up} &= \sum_{i=1}^{N} \left[Q_i \left(Black(F_k^{T_i}, T_i, \sigma_i^{up}) - Black(F_0^{T_i}, T_i, \sigma_i)\right)\right] \\ OSimPnL_k^{same} &= \sum_{i=1}^{N} \left[Q_i \left(Black(F_k^{T_i}, T_i, \sigma_i^{same}) - Black(F_0^{T_i}, T_i, \sigma_i)\right)\right] \\ OSimPnL_k^{down} &= \sum_{i=1}^{N} \left[Q_i \left(Black(F_k^{T_i}, T_i, \sigma_i^{down}) - Black(F_0^{T_i}, T_i, \sigma_i)\right)\right] \end{aligned} \tag{29}$$

where $Black$ denotes the Black model for option pricing.

Example 5: Continuing the previous example, the current futures price $F_0 = 2253.17$. Additionally, alongside her position in 10 long futures contracts labeled ETH-10JAN24, Alice also holds 10 long call option contracts labelled ETH-10JAN24-2300-C. The time to expiration and volatility for the option are $(T_i - t) = \frac{20}{365}$ and $\sigma_i = 0.2$:

$$MaxIVChange_{\text{up}} = (\frac{30}{20})^{0.3} \cdot 0.45 = 0.5082$$
$$MaxIVChange_{\text{down}} = (\frac{30}{20})^{0.3} \cdot 0.3 = 0.3388$$
$$\sigma_i^{up} = 0.2 \cdot (1 + 0.508) = 0.3016$$
$$\sigma_i^{down} = 0.2 \cdot (1 - 0.339) = 0.1322$$

OptionSimPnL				
Price Shock	Futures Price	up	same	down
-15%	1915.19	-229.18	-231.39	-231.40
-12%	1982.79	-221.70	-231.19	-231.40
-9%	2050.38	-197.98	-229.05	-231.38
-6%	2117.98	-138.04	-215.14	-230.58
-3%	2185.57	-13.86	-157.95	-217.02
0%	2253.17	202.62	0.00	-124.54
3%	2320.77	528.36	311.83	169.67
6%	2388.36	962.46	782.87	691.44
9%	2455.96	1487.82	1368.83	1332.67
12%	2523.55	2079.30	2014.17	2004.40
15%	2591.15	2712.50	2682.04	2680.07

$$OptionMaxLoss = 231.4$$

B.2.2 Option Contingency

Same as Futures Contingency, Option Contingency ($OContgy$) takes into account the impact of option trading on liquidity. Incorporating this into the margin calculation effectively mitigates potential risks associated with liquidity changes caused by trading activities. First, for options with a given expiration date i, sort these options by strike price (i.e., $K_1, K2, ..., K_n$). Based on this, sequentially calculate the option position for each strike price j:

$$StrikePos(K_j^i) = CallPos(K_j^i) + PutPos(K_j^i) \quad (30)$$

1.Calculate $AdjStrikePos$:

$$AdjStrikePos(K_j^i) = \begin{cases} \text{StrikePos} \cdot \frac{\left|\frac{K_j^i - F}{F}\right|}{\text{ATMRange}}, & \text{if } \left|\frac{K_j^i - F}{F}\right| < \text{ATMRange} \\ \text{StrikePos}, & \text{else} \end{cases} \quad (31)$$

2.Calculate $NetPosition$:

For the two strike prices closest to $ATMRange$, we directly use the adjusted strike positions as the net positions.

Then, we start with the two strike prices closest to the $ATMRange$, the approach involves expanding outward in both directions to encompass all strike prices. Specifically, the larger strike prices extend sequentially towards the highest strike price, while the smaller strike prices progressively expand towards the lowest strike price.

If the net position of the previous strike price is positive, the net position for the current strike price is the sum of the adjusted position for the current strike price and the net position of the previous strike price. If the net position of the previous strike price is zero or negative, the net position for the current strike price is equal to the adjusted position for that strike price.

3.Calculate $OContgy$:

$$ContgyFAPos_i = -\sum_{j=1}^{n} \min(NetPosition(K_j), 0) \quad (32)$$

$$TotalContgyFAPos = \sum_{i=1}^{M} ContgyFAPos_i \quad (33)$$

$$OContgy = OContgyFA \cdot TotalContgyFAPos \cdot I_0 \quad (34)$$

B.3 Portfolio Margin

B.3.1 Margin Exemption

If a user's position consists solely of long option contract, Dederi will not charge portfolio margin.

B.3.2 Margin Indicators

$$SimpleMM = -\min\left\{0, \min_{\Delta_k \in \Omega}\left\{\min_{\Theta \in \Lambda}\{FuturesSimPnL_k + OptionSimPnL_k^{\Theta}\}\right\}\right\} \quad (35)$$

where Λ represents the set of scenarios for up, same, and down, while Ω is consistent with section B.2.1.

$$MM = SimpleMM + FContgy + OContgy \quad (36)$$

$$IM = InitialMarginFA \cdot MM \quad (37)$$

$$IMRatio = \frac{IM}{Equity} \quad (38)$$

$$MMRatio = \frac{MM}{Equity} \quad (39)$$

Example 6: Continuing the previous example, current index I_0 is 2243.31 and the corresponding price of underlying futures $F_0 = 2253.17$. Alice has a portfolio consists of:

1. 10 long positions of ETH-10JAN24-2200-C and 15 short positions of ETH-10JAN24-2200-P with strike price $K_1 = 2200$;
2. 5 short positions of ETH-10JAN24-2500-P with strike price $K_2 = 2500$. Based on varying price movements of the underlying futures and different volatility scenarios, the simulated profit and loss for all of Alice's positions are as follows:

Price Change	Futures	Option			Total	Vol
	10Jan24	10Jan24				
	ETH	ETH				
		2200-P	2200-C	2500-P		
Size	10	-15	10	-15		
	-3379.76	-4342.19	-484.96	-1704.95	-9911.86	up
-15%	-3379.76	-4055.93	-675.80	-1687.98	-9799.47	same
	-3379.76	-3976.04	-729.06	-1687.32	-9772.17	down
	-2703.80	-3547.33	-338.92	-1382.41	-7972.46	up
-12%	-2703.80	-3150.90	-603.20	-1351.59	-7809.50	same
	-2703.80	-2991.10	-709.74	-1349.36	-7754.00	down
	-2027.85	-2830.41	-140.92	-1069.38	-6068.55	up
-9%	-2027.85	-2329.40	-474.92	-1017.89	-5850.06	same
	-2027.85	-2065.42	-650.90	-1011.49	-5755.68	down
	-1351.90	-2199.27	114.28	-769.31	-4206.20	up
-6%	-1351.90	-1618.17	-273.12	-689.91	-3933.11	same
	-1351.90	-1256.54	-514.21	-674.20	-3796.85	down
	-675.95	-1657.39	428.97	-485.80	-2390.16	up
-3%	-675.95	-1035.04	14.08	-372.48	-2069.39	same
	-675.95	-620.71	-262.15	-339.25	-1898.06	down
	0.00	-1203.73	802.49	-222.27	-623.51	up
0%	0.00	-584.29	389.53	-72.10	-266.87	same
	0.00	-182.27	121.51	-11.58	-72.33	down
	675.95	-833.31	1231.49	18.38	1092.51	up
3%	675.95	-256.52	846.97	203.76	1470.15	same
	675.95	79.05	623.25	298.85	1677.10	down
	1351.90	-538.17	1710.68	234.05	2758.46	up
6%	1351.90	-32.37	1373.48	448.06	3141.08	same
	1351.90	212.88	1209.98	577.22	3351.98	down
	2027.85	-308.50	2233.52	423.63	4376.51	up
9%	2027.85	111.93	1953.23	655.65	4748.67	same
	2027.85	271.78	1846.66	808.09	4954.39	down
	2703.80	-133.78	2792.99	587.06	5950.07	up
12%	2703.80	199.56	2570.77	824.28	6298.41	same
	2703.80	294.16	2507.70	981.88	6487.54	down
	3379.76	-3.71	3382.23	725.22	7483.49	up
15%	3379.76	249.87	3213.17	955.00	7797.80	same
	3379.76	301.54	3178.73	1099.11	7959.13	down

Under the scenario where the futures price falls by 15% with 'up' volatility, the total maximum loss is −9911.86:

$$SimpleMM = -min(0, -9911.86) = 9911.86$$

Then we can simply follow the steps and work out $OContgy$:
1.Calculate the Adjusted Strike Position:

Strike Price	**K=2200**	**K=2500**
Strike Position	5.00	-15.00
absolute $\frac{K-F}{F}$	1.93%	11.44%
within ATM Range	TRUE	FALSE
Adjusted Strike Position	0.97	-15.00

2.Calculate Net Position:

$$NetPosition(2500) = AdjStrikePos(2500) = -15$$
$$NetPosition(2200) = AdjStrikePos(2200) = 0.97$$

3.Calculate $OContgy$:

$$ContgyFAPos = -(-15) = 15$$
$$OContgy = 2243.31 \cdot 0.01 \cdot 15 = 336.50$$

Ultimately, we can then determine the Margin Indicators:

$$MM = 9911.86 + 134.60 + 336.50 = 10382.96$$
$$IM = 130\% \cdot 10382.96 = 13497.85$$

B.3.3 Parameters for Appendix B

Parameters[4]	**Value**
FContgyFA	0.006
OContgyFA	0.01
UpFA	0.45
DownFA	0.30
ShortTermVPower	0.3
LongTermVPower	0.13
ATMRange	0.1
InitialMarginFA	1.30
PriceShockRange	[-15%,-12%,...,15%]

References

[1] Gatheral, J. and Jacquier, A. (2014). Arbitrage-free SVI volatility surfaces. *Quantitative Finance*, 14(1), pp.59-71.

[2] Zeliade Systems. (2009). Quasi-explicit calibration of Gatheral's SVI model. *Zeliade White Paper*.

[3] Black, F. (1976). The pricing of commodity contracts. *Journal of financial economics*, 3(1-2), 167-179.

[4] Note: all parameters are subject to the latest values published on the Dederi official website