**How does Lyra work?**

This page provides an overview of the different areas of Lyra, including the Lyra Protocol.

**What is Lyra?**

To begin, we should make clear distinctions between the different areas of "Lyra", some of which may confuse new users.

* **The Lyra Protocol**: A suite of smart contracts that create an automated market maker for trading options on ERC-20 tokens on the Optimistic Ethereum Blockchain. Learn more about the protocol [here](https://docs.lyra.finance/overview/how-does-lyra-work#what-is-the-lyra-protocol).
* **The Lyra Interface**: A web interface that allows for easy interaction with the Lyra Protocol. The interface is one of many ways to interact with the Lyra Protocol. You can access the interface [here](https://app.lyra.finance/).
* **Lyra Governance**: A governance system for governing the Lyra Protocol, enabled by the LYRA token. Read more about governance [here](https://docs.lyra.finance/governance/council).

The following video is a great introduction to Lyra Protocol, courtesy of AD Derivatives (formerly Genesis Volatility)

**What is the Lyra Protocol?**

Lyra is an option automated market maker (AMM) that allows traders to buy and sell options on cryptocurrencies against a pool of liquidity. The Lyra protocol has two key user groups, liquidity providers and options traders.

**Liquidity providers (LPs)** deposit sUSD (a stablecoin) or USDC into one of the asset-specific Lyra Market Maker Vaults (MMVs). This liquidity is used to make two-sided (buy and sell) option markets for the asset that the vault specifies (e.g. ETH Market Maker Vault LPs quote options on ETH). LPs deposit liquidity to the vault to earn the fees paid when options are traded.

**Traders** use Lyra to trade options. They can either buy options from or sell options to the MMV. Traders pay fees (in the form of the bid-ask spread) to LPs, as compensation for their liquidity.

Get started by learning about how Lyra's AMM prices options [here](https://docs.lyra.finance/overview/how-does-lyra-work/options-pricing-and-the-amm).

**Options TLDR**

An option gives the holder the right to buy (call option) or sell (put option) an asset at a specified price (the **strike price**) at a certain time (expiration).

**Example:** The ETH 3000 strike call expiring in 14 days gives the holder the right to purchase 1 ETH for $3000 in 14 days' time.

This simple definition gives rise to a universe of possibilities - calls, and puts can be combined in different ways to create any imaginable payoff! This flexibility is a key reason why options are one of the most traded products in global financial markets. In particular, traders use them to:

* Hedge their risk （对冲风险）
* Lock in a payoff （锁定收益）
* Generate extra income on their assets（用他们的资产创造额外收入）
* Speculate on future price movements with precision（精确地推测未来的价格走势）
* Get leverage（杠杆）

And so much more! But all of that is out of the scope of a TLDR. Learn more about options [here](https://docs.lyra.finance/learn/options-101).

# Options Pricing & The AMM

This page explains how the Lyra Protocol MMVs price options.

Options market making fundamentally comes down to finding a market value for **implied volatility (IV),** the expected volatility of the asset from now until expiration. When implied volatility is high (low), the cost to buy (sell) an option **increases (decreases).**

The core mechanism underpinning the Lyra AMM is to increase implied volatility (and therefore the cost of options) when demand for options is high and decrease implied volatility when supply is high. By doing so, the AMM can converge to a market-clearing value for IV for each strike and expiry.

We'll get into more details as to how:

* Implied volatility translates into the price of an option
* How IV varies across strikes and expiries
* The AMM manages the risks associated with trading options

in the following sections.

## Black Scholes

### What is the Black-Scholes model?

The Black-Scholes model is the foundation of options pricing. It takes in the following 5 inputs:

* Asset price (S)
* Strike price (K)
* Risk-free interest rate (r)
* Time to expiry (T)
* Implied volatility (σ)

and outputs the price of an option. Knowing the inputs to the model is a good enough starting point to begin to reason about options - but interested readers can read more about the model and its derivation [here](https://en.wikipedia.org/wiki/Black%E2%80%93Scholes_model).

The important point to notice here is that, **of the 5 inputs to the model, 4 are widely known to all market participants**. The current price of the asset, the strike/expiry of the options contract, and the risk-free rate are all 'known' inputs to the equation.

The only input that is not observable is implied volatility. This means that when market participants are trading options, what they are really trading is implied volatility. Therefore, an options AMM must converge to a market-clearing value for IV, which is the approach that Lyra takes.

### How Lyra uses Black-Scholes

The Lyra AMM quotes options over a range of strikes and expiries. It does this by generating a market-driven value for implied volatility which varies by expiry and by strike, known as tradeVol. An option's tradeVol is the product of its expiry's baseIV and its strike's skewRatio.

**Example:** The July expiry has a baseIV of 100%, and the 3000 strike has a skewRatio of 1.1. Therefore the tradeVol for the July 3000 call is equal to 100% \* 1.1 = 110%.

When a trade is made, the relevant tradeVol is fed into a Black-Scholes pricing equation (which takes in the other 4 parameters), yielding the option price. This mechanic is explained in more detail in the next section, and for the full picture, check out sections 4 and 4.6 of the [whitepaper](https://www.lyra.finance/files/whitepaper.pdf).

## Volatility Smiles & Updates

### Volatility Smiles

One of the incorrect assumptions that the Black-Scholes model makes is that the implied volatility is constant across all strikes within the same expiry. In practice, different strikes have different implied volatilities, and this difference is driven by varying supply/demand for options on each strike. This phenomenon is known as a [volatility smile](https://www.investopedia.com/terms/v/volatilitysmile.asp).

Lyra's AMM accounts for volatility smiles by including a strike-specific adjustment to the implied volatility parameter that is used to price options, called the skewRatio.

The final implied volatility value fed into the Black Scholes pricing model is a combination of the baseIV of the relevant expiry, and the skewRatio of the relevant strike. That is:

tradeVol = baseIV \* skewRatio

### Volatility Updates

The standardSize parameter is defined as the number of contracts a trader would have to buy (sell) for the AMM to increase (decrease) the baseline IV level for an expiry by one percentage point. This is the mechanism that allows the AMM to converge to a market-clearing level for IV.

For each standardSize bought (sold) per strike/expiry combination, the AMM will increase (decrease) the ratio of that strike's volatility to the baseline IV by the skewRatioImpact parameter (a constant).

**Example:** The standardSize is 10 contracts, the baseIV for July is 100%, the skewRatio for the ETH 2500 strike is 1.1, and the skewImpact parameter is set to 0.005. If a trader buys 20 ETH July 2500 calls: the AMM will increase baseIV to 102%, and the strike volatility ratio to 1.1 + 0.005 \* 2 = 1.11. These values combine to give us the IV input for the trade: 1.11 \* 102% = 113.22%.

## Dynamic Fees

Lyra's fee function is made up of 4 distinct components:

1. 1.

A flat fee based on the option price

1. 2.

A flat fee for exchanging costs

1. 3.

A dynamic fee based on the pool's vega risk

1. 4.

A dynamic fee based on the difference between the expiry's baseIV and its GWAV, as well as the traded strike's skew ratio and vega.

1) and 2) are relatively simple fees that yield the spread that the AMM charges for providing liquidity.

The third fee is how Lyra manages its options exposure risk. The **AMM calculates its net vega exposure relative to the size of the pool** (the full algorithm is detailed in the [whitepaper](https://www.lyra.finance/files/whitepaper.pdf) section 5.2.1) which we call its vega utilization. This term is multiplied by a boolean parameter which is equal to 1 if the trade increases the net vega exposure of the pool, and 0 otherwise. This creates an asymmetric spread（不对称价差） around the Black Scholes theoretical value of the option, where trades that increase the risk of the pool are disincentivized relative to trades that hedge the pool.

**Example:** The July 3500 call is worth $100, and the pool is net short 500 vega. In this scenario, the AMM might be willing to pay $95 for the call, but only sell it at $110. In this case, the extra vega responsive fee is adding $5 per option for the buyer, making it relatively cheaper to sell.

The fourth fee is called the **variance fee** and is designed to charge more when markets are volatile. The variance fee will be present in all trades and scales with the traded strike's vega, skew, and the difference of the baseline volatility from its GWAV. In rapidly changing markets, the AMM runs the risk of losing out to impermanent loss. The variance fee adds positive expectancy to the AMM, thereby improving the possible outcome for LPs. For more detail, see the final section of <https://leaps.lyra.finance/leaps/leap-18/>.