Elements of DeFi

https://web3.princeton.edu/elements-of-defi/

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Lecture 16

Synthetics and Derivatives

Last Lecture: Stablecoins

- Wrapped – fiat
- Fiat based stablecoins
  - Centralized
  - Decentralized
- Algorithmic stablecoins
- Reserve coins

This lecture: Synthetics and derivatives

- Derivatives
  - Traditional financial product

- Synthetics are tokenized derivatives

Derivatives in tradFi

- Derivatives are financial instruments whose price/payouts are determined from the underlying asset
- Value is ”derived” from another asset
- Examples:
  - Futures
  - Options
  - Swaps

Futures

- A contract to agree to buy an asset in the future at a fixed price
- Settlement in cash or underlying
- Example:
  - Trader – farmer contract: Agrees to buy corn at the price of $10/Bushel in 3 months
  - After 3 months: Price of corn = $11
  - Trader profits $1, Farmers guaranteed a predictable income
- Counterparty risk: What if trader disappears?
- **Futures are standardized and written by central parties** – reducing counterparty risk and making them fungible

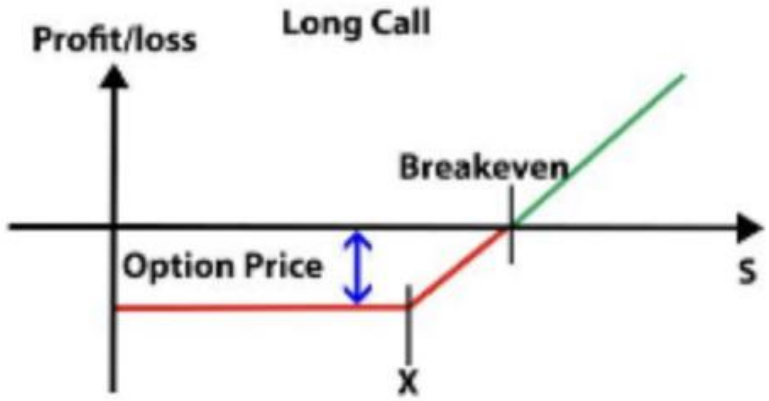
Options

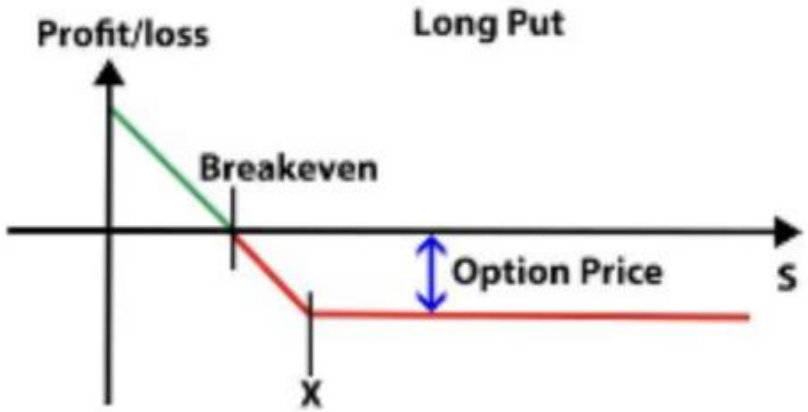
- Options are types of derivatives that give owners a **right, but not an obligation,** to buy or sell an asset at an agreed price
- Options are written by a market maker and sold to an owner – the market maker is obligated to sell/buy the asset if the owner exercises its right to buy/sell by an expiry date
- Option writer charges a premium for writing the option and taking the risk

- Call – Option owner has a right to buy asset at an agreed price
- Put – Option owner has a right to sell asset at an agreed price

Options – return profiles

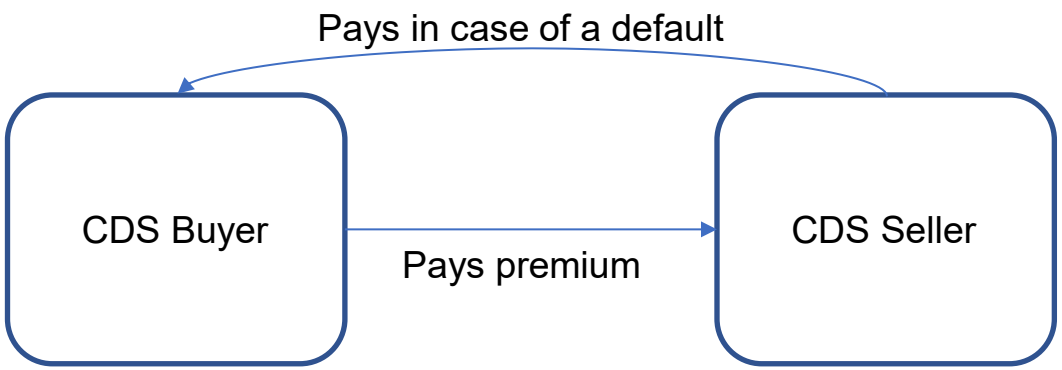
- Call – Option owner has a right to buy asset at an agreed price
- Put – Option owner has a right to sell asset at an agreed price





Swaps

- Exchange asset value without transferring assets
- Example: Credit Default Swaps (Default insurance)



Synthetic assets: Tokenized Derivatives

1. **Tokenization of assets**
   - Cryptocurrency: WBTC, WETH
   - Stock: Apple, TSLA
   - Commodity: gas, gold
   - Index: DeFi Pulse Index

2. **Futures**
   - Perpetuals: DyDx

3. **Options**:
   - Ribbon

Tokenization of Assets:

- Wrapping cryptocurrencies
  - Actually hold the assets
  - Wrapping a basket of cryptocurrencies (indexing)

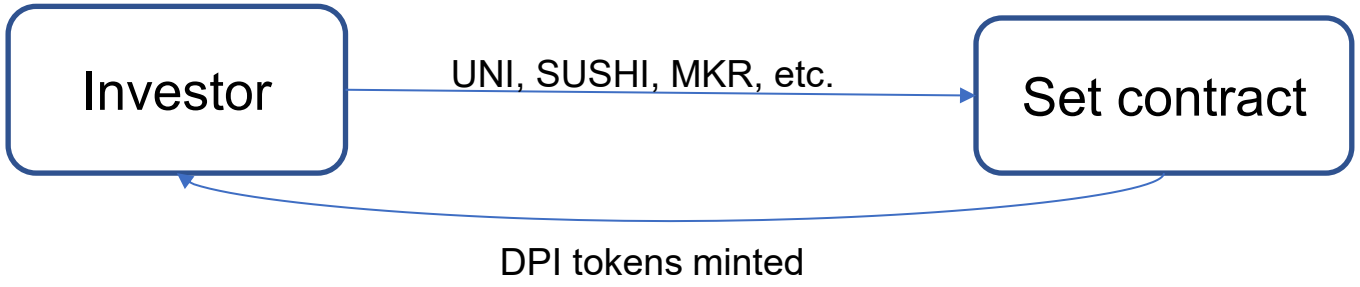
- Tracking asset prices
  - No need to hold the assets
  - Synthetics

Wrapping as a tokenization mechanism

- Price is pegged to another asset

On-chain ETFs – Set protocol

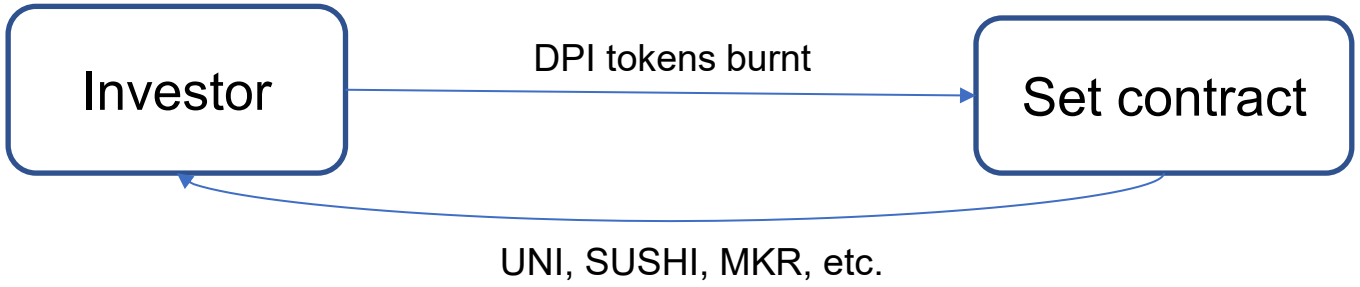
- Used to mint a basket token such as the DeFi pulse index (DPI)
- Wrapped Token on a basket of assets
- Maintained by issuance and redemption mechanism



Issuance

On-chain ETFs

- If price of DPI lower than underlying assets, investors will burn DPI for assets
- If price of DPI higher than underlying assets, investors will deposit assets to mint DPI



Redemption

Need for synthetic assets

- Bring real world assets to blockchain – Synthetic Gold, USD pegged Stablecoins
- Remove need for token transfers across chains - WBTC
- Enable complex financial instruments like options and derivatives
- Borderless access to assets – Apple stock on-chain

Collateralized Debt Position based synthetics

- Example: Synthetix, Mirror, UMA
- Use collateral asset to mint a synthetic token
  - Synthetix: SNX, Mirror: UST (Depreciated due to collapse of Terra)
- Utilize Oracles to valuate the synthetic
- Maintain a Minimum Collateral ratio (MCR)
- If value of synthetic asset rises, liquidation pressure leads to buying pressure – decreasing supply of the synthetic

CDP based synthetics

Assumptions	
Minimum Collateral Ratio	150%
Collateral Auction Discount	0%
Initial Shares of Asset	1.00
Initial Asset Price	$90
Initial Collateral	$150

When the minted asset's price rises and the collateral ratio falls below the minimum collateral ratio, the protocol will sell collateral to buy back shares of the minted asset to burn.

Time	Shares of Asset	Asset Price	Collateral Value	Collateral Ratio
0	1.000	$90	$150	167%
1	1.000	$100	$150	150%
2	1.000	$101	$150	149%
2.01	0.970	$101	$147	150%
3	0.970	$110	$147	137%
3.01	0.727	$110	$120	150%
4	0.727	$100	$120	165%

CDP based synthetics

- Features:
  - Can be generalized to any derivative given oracle and liquidator support
  - Pools are not needed for exchanges:
    - Convert from one synth to another according to price oracle
    - Zero slippage, infinite liquidity – there can be more sBTC than the total supply of BTC

- Vulnerabilities:
  - As secure as the price of the collateral – Collapse of Mirror on Terra blockchain
  - Reliance on oracles

Futures

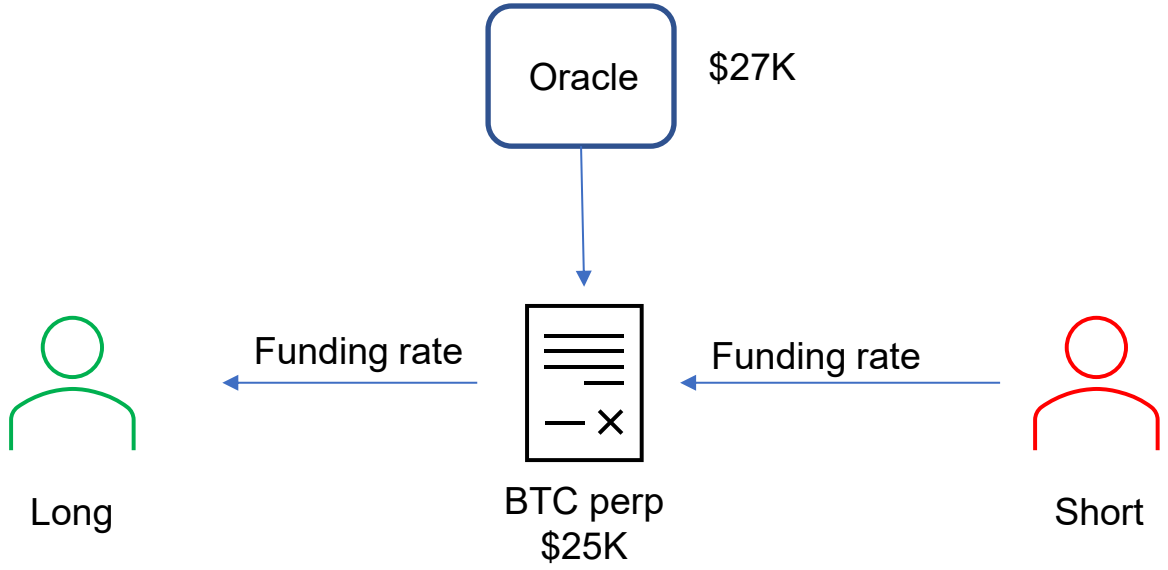
- Tracking asset prices
  - No need to hold the assets
  - Perpetuals

DyDx: Perpetuals

- Perpetuals speculate on future price of an asset without any expiry date – **Futures without expiry**
- There is no exchange of assets between buyers and sellers
  - No need to actually exchange assets at expiry
- Short and long positions on the perpetual contract create the market
- Price of perpetual contract is controlled by the **funding rate mechanism**

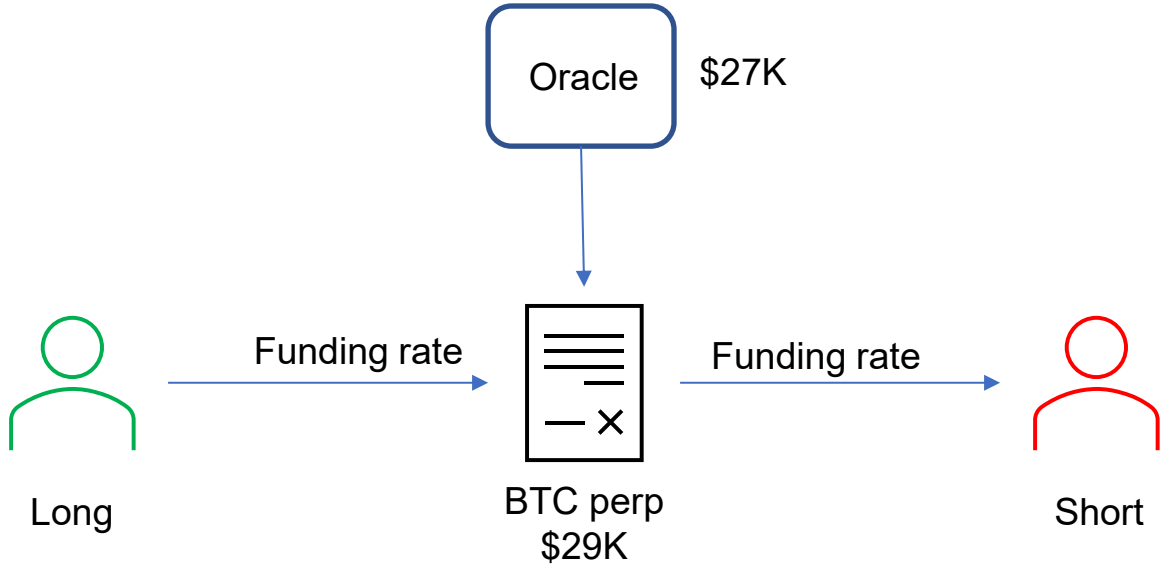
DyDx: Perpetuals – price discovery

- Holders of long positions pay holders of short position if price of perpetual contract is lower than the trading price of asset – purchasing pressure



DyDx: Perpetuals – price discovery

- Holders of short positions pay holders of long position if price of perpetual contract is higher than the trading price of asset – selling pressure

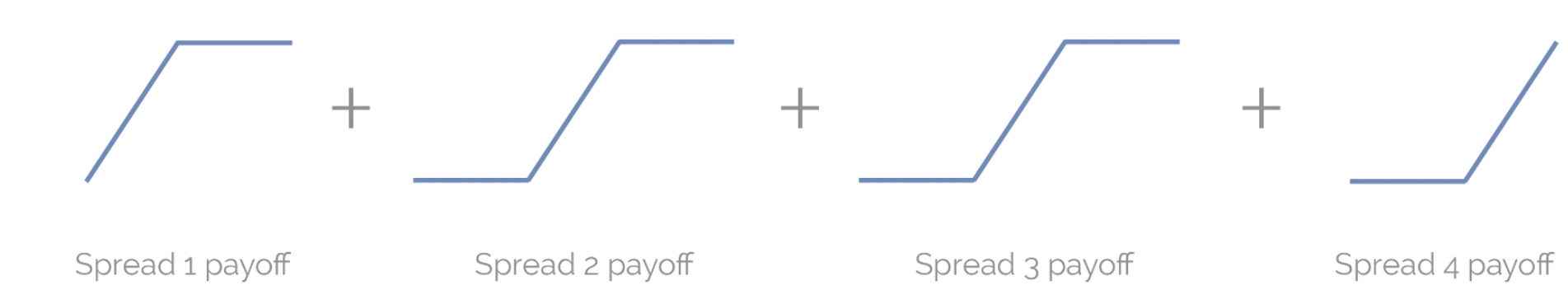


Options

- Option AMMs
- DeFi option vaults (DOVs)
- AMM LP payoff-derived oracle-free options

Option AMMs - Charm

- Take a pair of options whose payoff sums to a constant and create an AMM for that pair
- Applies a prediction market scoring rule to these assets
- Offers spreads that can be combined to create a variety of options



- LSMR rule ensure that there is enough collateral to back the payoffs

DeFi Option Vaults - Ribbon

- Mints options with weekly expiration
- Number of options minted are controlled by the liquidity available to the protocol
- Premium on the option is calculated through an auction mechanism
- Profit/loss as an option maker is transferred to the protocol's LPs

LP return derived oracle-free synthetics

- Liquidity providers to AMMs have a payoff curve (Lab 8)
- The payoff curve depends on the bonding curve and fees
- Payoff curve can be manipulated to fit an option by:
  - Changing bonding curve
  - Modifying liquidity profile on Uniswap V3 like protocols
  - Managing fees
- Example: Replicating Market Makers, Panoptic

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