DYMMAX: liquid decentralized options

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Abstract

We present Dymmax, a novel protocol aiming to build a decentralized platform for options emission and secondary circulation.

Dymmax is based on a well-studied parimutuel model[1], allowing to issue options without a sellers. Buyers of various option types (PUT, CALL, IRONFLY) form a joint bank, which is guaranteed to be sufficient for expiration payments. The price of every option type is calculated off-chain when all bets are done for maximum auction efficiency.

All matched orders are tokenized in the form of ERC-20 tokens, providing a way for the secondary market. New at-the-money optionsсобе with the same expiration day are issued every day, supplementing existing supply and increasing liquidity.

Introduction

The emergence of the digital currencies and assets market is an important event in the global economy itself. Despite of the fact that it is pretty small at the moment and hard to apply for everyday purposes, we can witness the beginning of the era of a financial services for digital assets. They operate both according to the classical centralized scheme (e.g. [5,6]) and also in decentralized way (so-called DeFi [7,8]) allowing to exchange assets, extract yield with time, tokenization of real assets and more.

As in any financial market, cryptocurrencies sector include parties with various goals: speculators aiming to make money on short-term fluctuations, investors who set up for a long-term growth of the assets market value in their portfolio, and also miners. And all types of investors need both speculative and safe instruments. These instruments must not violate the general concept of digital currencies, while providing opportunities comparable to classical exchange instruments.

For these purposes, classic delivery and settlement futures and options were developed, some of them are used to benefit from fluctuations in exchange rates, others allowed to insure assets against inevitable fluctuations of their value, but also create a niche for liquidity providers, which brings companies considerable income ...

But why not just take and transfer futures and options to a decentralized platform? It is what we want to talk about in the next section and conduct a comparative analysis of services.

Research

Exchange options

Large market participants such as Deribit and other centralized exchanges provide access to derivatives in the classic form, where the exchange guarantees contractual obligations. Of course, such instruments are no different from futures and options traded on large international exchanges and carry the organizer's risks, and are not subject to secondary circulation outside the exchange. In the long term, the application of these instruments is aggravated by the lack of tools to protect the organizer himself from sudden movements. In other words, there are no instruments on the market that correlate with digital currencies and compensate for the risks of a sharp and significant change in the exchange rate. This can be easily determined by calculating the correlation coefficient beta using the formula below:

(1) $\beta = \frac{Cov(r_i, r_m)}{\sigma_m^2}$

r_i - portfolio i-share yield;

r_m - market return;
σ_m^2 - variance of market returns.

At the same time, it is difficult to calculate the correlation coefficient for low-liquid digital assets. For this reason, further we will consider cryptocurrencies and other digital assets that do not have equivalents in other money markets as unhedged assets.

Since 1973, Fischer Black and Myron Scholes have published a formula for pricing European options for underlying assets traded on the stock exchange (Black – Scholes Option Pricing Model).

Call Option price:

(2) $C = SN(d_1) - Xe^{-rT}N(d_2)$, where

$$d_1 = \frac{ln(\frac{S}{X}) + (r + \frac{\sigma^2}{2})T}{\sigma\sqrt{T}}$$
$$d_2 = d_1 - \sigma\sqrt{T}$$

Put Option price:

(3) $P = Xe^{-rT}N(-d_2) - SN(-d_1)$

Description:
C - Call Option price;
S - underlying asset price (spot);
$N(x)$ - cumulative normal distribution function;
X - option strike price (strike);
r - risk-free interest rate;
T - time until option exercise;
σ - return volatility of the underlying asset.

The Black-Scholes model is based on several statements, including the circulation for the underlying asset on the exchange, and the expected volatility (IV) is the key factor affecting the option value. In the case of exchange options and a centralized trading organizer, the expected volatility is determined by the market itself and can be calculated from the bid and ask prices for each contract using the above formula. However, in the case of digital asset options, the determining factor in setting the option price is the seller's inability to hedge the risks, which in turn greatly increases option premiums.

As a result, we get contracts traded on centralized exchanges without the possibility of circulating on the secondary market outside the organizer in the form of ERC20 tokens with high premiums, which reduce the likelihood of breaking even for the buyer to a minimum.

Decentralized options

It is impossible to ignore the implementation of classic options full of collateral. This type of derivatives is more suitable for the implementation of options on digital assets and does not contradict the basic concept of cryptocurrency. Projects offering similar and derivative instruments based on smart contracts already exist. However, to conclude such a contract, two parties are always required for the transaction, a buyer and a seller. In this case, the buyer is obliged to put full asset value in the contract in the amount of the strike price. The seller, in his case, must put the asset itself into the contract. Such contracts can function without a centralized trading organizer and can be safely handled in the form of ERC20 tokens in the secondary market using a decentralized interface. But on closer examination of this scheme, we can find several significant disadvantages:

- the need to reserve a large amount of money for the entire duration of the contract, while this amount is passively handled on the smart contract until it expires.
- lack of the necessary liquidity due to high requirements for collateral on the part of buyers and sellers.
- follows from the problems of hedging the seller's risks, that was described above. In this case the seller increases the premium for the contract to compensate for the risks, which in turn causes the buyer's dissatisfaction and thus imposes restrictions on the development of this implementation scheme based on the blockchain.

High premiums and low liquidity are not attractive for market makers and are constraining factors for the development of such instruments.

Options on non-hedged assets

Let's recall the attempts to exercise weather options to hedge the risks for enterprises in the agro-industrial sector. The complexity in the implementation of these contracts has a lot of similarities with the problem of cryptocurrency options. Despite the fact that there are phenomena in the weather derivatives market that can be used to hedge the seller's risks, for example, the rise in the cost of electricity at times of abnormally high or low temperatures, which to some extent allows the seller of the option to protect against the risk of large losses. Premiums for such contracts are very difficult to assess. The cryptocurrency and digital asset market does not have similar persistent correlations with other assets that can be used to cover the seller's long-term risks.

Sweepstake

In 1874, Joseph Oller invented a method for determining payout rates for horse racing bets using a shared pool (Parimutuel betting). Oller's method gained immense popularity and became known as a tote, the main advantage of which is a guarantee of payments to all winners based on a pool of bets. Before the start of a competition or other event, a book of bets is opened for everyone who wants to make their bets. After the book or auction is closed, as it is sometimes called, the odds are calculated using the formula below.

(4) $W_t = \sum_{i=1}^{n} W_i$, where

$W_1, W_2, ..., W_n$ - pool bets

The indicated formula is valid for events with n number of outcomes and one winner. The payout ratio is calculated after the winner is determined.

(5) $P = \frac{W_t}{W_m}$, where

P - payment to the m bettor for every dollar bet.

Sweepstake is used mainly for betting on sports events or other, which will happen very soon. Despite the absence of a seemingly visible connection between financial instruments and sports betting, mathematicians and economists have done scientific work to study the use of sweepstake as a model for pricing options on unhedged assets. As a result of the research, it became possible to create instruments whose behavior is completely similar to vanilla options at a predetermined price of the underlying asset.

As a solution to the problem of creating decentralized options for digital assets, including cryptocurrencies and tokens, the parimutuel betting method was taken and in the next section we will talk about all the features of its application.

Decision and rationale

Assertions

When considering a solution to the problem of decentralized options for digital assets, it is necessary to make several statements based on which the model of their application will be described:

- The behavior of instruments based on parimutuel betting repeats the behavior of vanilla Call and Put options at a predetermined price range of the underlying asset. In our case, we will consider $\pm 50\%$ of the value of a cryptocurrency with a price of 100;
- To calculate premiums, the presence of buyers and sellers is not required, as is the case with exchange contracts. But to determine the options prices, it is necessary to form a pool of orders; for this purpose, an auction has been introduced that is valid for 24 hours from the moment of its opening;
- The ATM (At The Money) strike is determined at the time of the auction closing and the option premiums are calculated. In other words, all buyers who applied to buy options with an ATM strike at the opening of the auction will receive ATM contracts regardless of fluctuations in the price of the underlying asset during the auction.

Parimutuel with fixed odds

The solution was taken from the works of Yinyu Ye and Jeffrey Lange (links: [1], [2], [3]), which is a parimutuel model with fixed payments. The pricing model is based on parimutuel betting with very significant improvements. As we know from the previous sections, the parimutuel method implies floating payments unknown until the end of the event and counting the winners. And in the case of options, traders must know the future payout. In vanilla options it is 1:1, that is, 1 point of the price of the underlying asset for each point of difference between the exercise price and the price of the underlying asset at the exercise date.

The settlement payouts for vanilla options are calculated using the following formulas:

(6) $IV_c = max\{0, P_m - P_s\}$

(7) $IV_p = max\{0, P_s - P_m\}$, where

IV_c - intrinsic Call option value;

IV_p - intrinsic Put option value;

P_m - price of the underlying asset at the exercise date;

P_s - Strike price.

Payouts for the instruments must be exactly the same as the above formulas. Let us consider the solution in more detail. For this we take the price range of the virtual asset [50,150] and divide it into sections with a step of 10. As a result we will receive a set of segments [50,60, ..., 150], each of which will further be the state *s*. From a set of states, you can build any option whose behavior for a segment is completely similar to a vanilla option on a designated area. For example, we simulate a call option with a strike of 100. For this we need that for every 10 points of price increment we receive 10 points of increment of the option's intrinsic value. For this we need to distribute the rates as follows:

(8) $[50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150]$ - set of states;

(9) $[0, 0, 0, 0, 0, 0, 10, 20, 30, 40, 50]$ - vector *p* containing a set of rates broken down by states (8) in price points of the underlying asset.

For this distribution it follows that on the date of exercise, the intrinsic value of the option with the underlying asset price of 140 points will be 40 points, which is completely analogous to the intrinsic value of the call option. In further calculations, we will use 2 Call and Put options with a strike of 100, presented as vectors (9) to form a basket of orders. Next, let's move on to the most difficult part of the solution - calculating option premiums.

The pricing model under consideration contains the following parameters:

1. Initial liquidity - the amount set by the market maker, presented as a vector Θ_s;
2. Array of vectors p_s describing orders to buy options;
3. The array of vectors y_s containing the floating payout bet is 0.

(10) $p_s > 0$, $s = 1, 2, ..., S$

(11) $\sum_{s=1}^{S} p_s = 1$

(12) $M = \frac{\Theta_s}{p_s} + y_s$, $s = 1, 2, ..., S$, where
M - total money pool.

After designating the sum of prices of all states and equating the required payment of 1 point per 1 point of the price movement of the underlying asset (11), we obtain a system of equations. The solution of which will give the required set of premiums. The vector obtained as a result of the solution containing a set of prices broken down by states allows calculating the premium for any option from the order book.

The described method, in contrast to classical exchange trading, provides all traders whose orders were executed with the same and at the same time the best prices, which is a significant distinguishing feature of the pricing model under consideration.

Example of premium calculation

Let us calculate the premiums for call and put options described by vector (9) and its mirror analogue based on the pricing model above. In the example, we will omit cases with a large set of different contracts due to the complexity of the calculation and the algorithm for selecting and executing orders.

Let's set the initial vector of liquidity in the form:

$$[8, 8, 8, 20, 20, 50, 50, 20, 20, 8, 8, 8]$$

Add 5 orders to the array of vectors for the purchase of call and put options with a strike of 100.

$[0, 0, 0, 0, 0, 0, 0, 10, 20, 30, 40, 50]$ - call option;
$[50, 40, 30, 20, 10, 0, 0, 0, 0, 0, 0, 0]$ - put option;

As a result of substitution of the given parameters into equations (10) and (11), we obtain a solution in the form of a vector containing the prices of states:

$$[0.12, 0.07, 0.04, 0.09, 0.07, 0.16, 0.07, 0.09, 0.04, 0.07, 0.12]$$

Using state prices, we can calculate premiums for call and put options:

$C = 13.41$ - call option premium;
$P = 13.41$ - put option premium;
$\mathrm{M} = 312.16$ - total money pool.

Having obtained the values of the options premiums and the total money pool, we can demonstrate more importantly the property of the considered solution - guarantees of payments in any market scenario.

Scenario 1:

The price of the underlying asset at the date of execution is 50;
The total payments for put options calculated by formula (7) will be 250, which is significantly less than the value of the money pool.

Scenario 2:

The price of the underlying asset at the date of execution is 150;
The total payments for call options calculated using formula (7) will be 250, which is significantly less than the value of the money pool.

In the case of scenarios in which the price of the underlying asset at the time of execution is within the boundaries of the range, the value of payments will be below 250, since we considered the points at which the values of payments are maximum. Outside the considered range, payments are completely identical to payments at the borders of the price range.

The balance of funds after the fulfillment of obligations for options after their execution is transferred to the market maker, who, using distribution, can make changes to the value of certain contracts. Working with market makers is discussed in more detail in the next section.

Implementation and architecture

In the process of adapting the model for implementation in the form of a decentralized protocol, an algorithm was developed from conducting the first trading to exercising options and making payments. The trading mechanism for these instruments is divided into several phases:

1. Series - initialization of a new instrument in the contract storage, indicating the main parameters, such as the range of options, time of execution, price step;
2. Auction - accepting applications within 24 hours from the opening of the auction with a floating premium, closing the auction with the calculation of premiums and ATM strike, opening (prolonging) the auction for the next 24 hours with the transfer of unexecuted applications or their cancellation;
3. Delivery - made after each closing of the auction and the determination of the orders that have fallen for execution, implemented in the form of sending ERC20 standardized tokens to the addresses that submitted the orders;
4. Execution - the prolongation of auctions is terminated a few days before the execution of the contract, at this time there is only secondary circulation of previously issued contracts. After the due date, the owner of a profitable token can receive a payment using the web interface or directly interacting with a smart contract.

In the following sections, we will take a closer look at each stage, as well as calculate premiums for a virtual asset.

Series

The main task of the series is to set parameters for the entire trading period from initialization of the series to its completion. The series contains the following parameters, which are unchanged for the entire duration of the series:

— Underlying asset;
— Due date;
— Price step;

— The range of options.

The series also carries a certain set of functions, such as:

- — Closing and prolongation of the auction;
- — Obtaining the price of the underlying asset at the close of the auction and the onset of the execution date;
- — Accounting and storage of the money pool;
- — Fixing the price of contract execution;
- — Emission of ERC20 tokens;
- — Making payments on options after the exercise date.

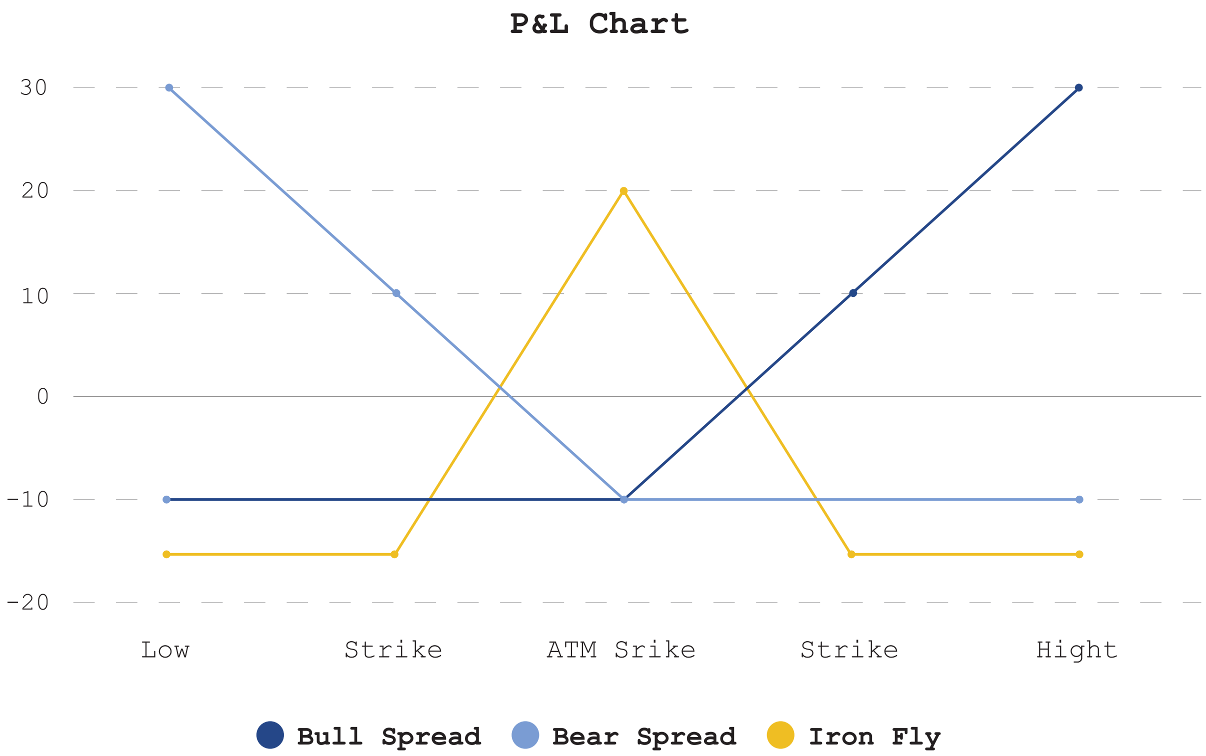
Prolonged auction

Unlike a series that performs only technical functions and is responsible for storing constants and money pool, an auction, while being a part of a series in a single copy, is responsible for collecting orders from buyers and pricing options. The auction is based on an order book, in which all traders that wish to purchase options send orders with the following parameters:

- — Strategy type;
- — Maximum number of contracts;
- — The highest possible price for order execution.

The period of the auction is 24 hours in the first implementation of the protocol, after the expiration of the validity period the auction stops accepting the applications. Next, the algorithm for determining the cost of price states and calculating premiums based on the received prices comes into play, which also includes enumerating the received limit orders and selecting executed, partially filled and rejected orders. Option premiums are determined using the system of equations (10) and (11).

In the current implementation of the protocol, with the complexity of the pricing model and the novelty of instruments in the cryptocurrency market, instead of the vanilla options analogs, such as call and put options, we decided to introduce ready-made option strategies designed for basic market scenarios, such as an increase in the rate, decrease and a sideways trend. Below are the risk profiles for the listed strategies.



The profit / loss values on the charts are conditional. Real values are determined when the auction is closing.

ATM strike

Recall that a distinctive feature is the necessity to collect orders to determine option premiums at current demand. This decision imposes complex ATM determination of options during the auction. To solve this problem, it was decided to determine the ATM strike at the close of the auction. For buyers this is a positive introduction, since all the listed strategies are related to the ATM strike. Then all executed orders will receive sets of strategies with ATM strikes valid at the time of the auction closing. This scheme provides important advantages over determining the ATM strike at the beginning of the auction, such as:

- Regardless of the moment of application, terms are equal for all participants;
- At the close of the auction, all participants whose orders have been executed receive ATM strike strategies, regardless of price fluctuations during the auction period;
- All members receive contacts at the best prices, without spreads and slippages.

Market maker

The DYMMAX protocol does not contain the classical concept of a market maker as an exchange participant which maintains liquidity in a selected instrument by holding buy and sell orders with a set spread.

The main task of the market maker combined with the pricing model laid down in the protocol - is to create initial liquidity for the start of the auction. During the course of the auction, the market maker can change the amount of invested funds, as well as their distribution by states within the allowed range, which in turn will affect the prices of options. Thereby the market maker can make adjustments based on market expectations.

The market maker receives payments after all option obligations are settled, and the risk and profit are determined at the close of the auction and cannot exceed the amount invested. Tools to help assess risks are available through DYMMAX terminal int the market maker's section.

- The market maker maintains a pool of liquidity, not a separate contract;
- There is no need for constant monitoring of buy and sell orders, as is the case with the classical exchange market or decentralized exchangers;
- Risks and rewards are predicted in advance.

Delivery and ERC20 token

After the closing of each auction and the calculation of the premiums, ERC20 tokens are delivered to the holders of executed orders. The token contains information about the underlying asset, strategy type, strike price and execution date. The names of tokens are standardized and anyone can easily recognize the parameters listed above from the name, all execution dates are using exchange methods of designation.

$$DMX - ASSET\_CODE - STRATEGY\_CODE - MONTH\_CODE - YEAR\_CODE$$

When a token is transferred to another address, the owner of this address becomes the owner of the token and receives the full right to receive payment when the contact is executed.

Execution

After the due date, any contact holder can get paid on profitable contracts. To do this, you need to use the DYMMAX terminal and call the payout function, which will transfer the calculated amount to the holder's address in exchange for tokens.

Contract payments are calculated using the following formulas:

$IV_{Bull\ Spread} = max\{0, P_m - P_s\}$ - for Bull Spread
$IV_{Bear\ Spread} = max\{0, P_s - P_m\}$ - for Bear Spread
$IV_{Iron\ Butterfly} = R - abs\{P_s - P_m\}$ - for Iron Butterfly

R - allowed price range;
P_m - price of the underlying asset at the exercise date;
P_s - strike price.

After the call to the execution function, the canceled tokens are burned out. Unused tokens can be transferred to another recipient.

DMX token

Most centralized cryptocurrency exchanges have their own utility token, which allows you to reduce transaction fees and pay for various services. The role of the own token (DMX) for the decentralized Dymmax protocol increases significantly. In addition to utilitarian properties, it will be used as a governance token, which allows to take part in the development of the Dymmax ecosystem by voting.

The maximum emission of the DMX token will be 10M, and will be distributed as follows:

%	DMX tokens	Where	Vesting
21%	2 100 000	Public sale	Instant
7%	700 000	Community airdrops	Within a year after IEO
15%	1 500 000	Ecosystem &	Within a year after IEO

		partners	
15%	1 500 000	Seed sale	1 year after IEO
12%	1 200 000	Staking	25,000 per month for 4 years
30%	3 000 000	Foundation	50,000 per month for 5 years

The value of a DMX token consists of (but is not limited to) the following components:

- Voting to add new options. A series of ETH / USDT auctions will be launched initially. DMX token holders will be able to vote on adding new series of auctions.
- Cashback from trading commissions. For each trade, a Dymmax user pays a 0.2% commission, however, this commission can be significantly reduced using a DMX token. A trader with 1000 DMX tokens on his balance receives 10% cashback, 2000 DMX - 20%, 4000 DMX - 40%, 10000 DMX - 60%, 25000 DMX - 80%, 50,000 DMX - 90%, 100000 DMX - 100%.
- Payment for services of the Dymmax ecosystem and partners. All services of the Dymmax ecosystem can be paid using DMX tokens. We will strive to ensure that our partners also accept DMX tokens if possible.
- Token burning: every quarter, depending on the commissions received from trading, we will burn DMX tokens. Ultimately 15% of the DMX emissions will be burned.
- Voting on Dymmax development paths. We strive to be a completely decentralized project, so that our community will always have a decisive role in the development of the ecosystem.

Application

Derivatives are an integral part of the money market; the range of their application is huge, without exaggeration, from short-term speculation on events to hedging long-term portfolios. We want to highlight interesting practices such as as:

- Short sale of digital assets without paying the stake;
- Hedging of digital assets;
- Market for predictions and non-standard tokens;
- Trading on events;
- Weather Tokens.

The possibilities of options based on the parimutuel betting with fixed odds model are very wide and the cryptocurrency market is an ideal start for using this tool.

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