ISM: A Decentralized Insurance System

January 15, 2021

Abstract

We offer a new system of DeFi insurances covering risks borne by fluctuations in tokens' prices. Importantly, participants benefit from "insurance-mining", i.e., issuing, providing, and liquidating insurance can automatically generate additional returns in ISM. After launching the products, customers are incentivized to become liquidity providers for ISM to facilitate trading and earn additional tokens.

1 Introduction

The introduction of bitcoin (Nakamoto, 2008) started a whole movement of the economic paradigm shift towards Decentralized Finance (DeFi) empowered by decentralized technologies, particularly Blockchain and Distributed Ledger Technologies (DLT), which represent the common ground for enabling borderless, immutable, and transparent technology.

Despite its great potential in reshaping the financial system, how financial transactions are done, and restructuring the regulatory frameworks (Zetzsche et al., 2020), a new category of risks is gradually present in the DeFi ecosystem. When putting savings in an account that is part of a smart contract in a DeFi system, users are substantially less likely to expose to a counterparty risk than in the traditional finance system such that the bank will go bankrupt and the deposit insurance will not be able to support all the covers. However, it may expose to risks of a coding security fault of the smart contract itself. The smart contract may have a bug that leads to liquidation of savings account or theft by another party (Popescu, 2020). This can be extended to all DeFi applications at this stage.

The advantage of the DeFi ecosystem is that market participants can develop new measures that are unavailable in the traditional financial system – it enables permissionless financial innovation (Chen and Bellavitis, 2020). Therefore, some DeFi insurance products are designed to deal with the aforementioned risks of smart contract loopholes. One of the most well- known DeFi insurance project is Nexus Mutual (Karp and Melbardis, 2020), which covers risks of smart contract loopholes and featured by its DAO governance.

All existing DeFi insurance products are designed to cover rare events such as smart contract loopholes and fraud. However, almost all market participants in the DeFi ecosystem are also exposed to crypto current price fluctuation risks caused by rumors about founders and development teams, regulation risks, and other risks involving private knowledge about projects underlying the tokens at stake. Currently, market participants have no better choice to hedge these risks but to seek help from derivatives such as options contracts on Convexity. The markets for derivatives, however, is in its early stage and do not always offer sufficient products that satisfy the demands to cover risks to which market participants expose.

In response to the demand of most market participants who wish to have their risks covered, we offer a new decentralized insurance platform where DeFi users can provide covers to other users and both sides benefit from the deal. A holder of token, say, token A, is able to stake

in the holdings on the platform and then mint a combination of tokens: A Claim token and an Unclaim token. In doing so, s/he specifies at what price (strike price) is s/he willing to exchange token A with token B. S/he can then sell the claim token to a market of claims and then become an insurer who provide cover to the claim holder. The claim token is in effect an American option. In case the claim holder exercises the claim, the insurer is bounded to exchange the underlying tokens at the strike price. Hence, the value of the unclaim token is equal to the difference between the underlying token value and the value of the claim token.

We propose the concept of "insurance-mining", meaning that as the token holders mint the claim and unclaim tokens, they obtain an ERC-20 token, ISM, in return. The total amount of return in the insurance-mining is fixed and will all be allocated within the first 60 days. The mining process happens during minting the claim tokens. The ISM obtained are rewards to insurers who contribute to the platform. The platform also offers two sorts of liquidity mining that users can benefit from. Providing liquidity to claim markets, i.e., faciliate trading of claims, allows these liquidity providers to receive ISM as rewards. In addition, providing liquidity to the ISM market and facilitate trade between other ERC-20 tokens and ISM also allows earning a reward in an LPtoken.

2 Overview

Special features: DeFi insurances offered by ISM is special in that it allows the first and unique "insurance-mining", i.e., users yield a mining return from minting the claim and unclaim tokens. In other words, creating new insurance products is rewarded by insurance-mining.

Participants: There are four types of participants on the platform after launch, including insurers, claim-holders, ISM liquidity providers, and claim/unclaim token liquidity providers.

- **Insurer**: Once a token holder stake in a holding of tokens in the platform and mint claim tokens, s/he becomes an insurer. The insurance is effective if the claim token is sold. Selling the claim token implies thath the insurer commits to exchange the original holding of the token to a different token at a pre-specified price as long as the claim holder wishes to.

- **Claim-holder**: A user becomes a claim holder once purchased a claim. Holding a claim gives the right to exercise an American put option anytime before expiration date and sell some of the tokens the user holds to the insurer at a pre-specified strike price. The right to selling at a strike price serves as a protection of the claim-holder's holdings.

- **ISM liquidity provider**: Minting claim and unclaim tokens enables the insurer to obtain some reward in ISM. To faciliate trading of ISM, the platform provides a liquidity pool where ISM holders can provide liquidity and be rewarded in another ERC-20 token LP-token, i.e., liquidity-mining. ISM holders may also choose not to provide liquidity in the market pool, but rather to burn the ISM at hand to initial new insurance products on the platform.

- **Claim/Unclaim token liquidity provider**: There is a secondary market for claims where claim holders and insurers can provide liquidity of claims and obtain rewards for doing so. The liquidity pool allows users to purchase and exchange claims.

Total supply of mining: A total amount of 60,000 ISM will be allocated to insurers and liquidity-providers. The initial allocation is as the following: 10% is allocated to insurers for their contribution in providing insurance on the platform; 20% is allocated to liquidity providers in the claim and unclaim token pools; 20% is allocated to liquidity providers in the pools that exchange ISM with other tokens; 20% is allocated to crowdfunding; and the rest 30% is allocated to community members and DAO governance automatically in fixed percentage as new blocks are created.

A quick introduction to the system: We start by a simple example to illustrate how the system works. Suppose a user stakes in a unit of underlying token, say USDT, and specifies that s/he is willing to provide an insurance to guarantee that s/he will purchase ETH at a cost of 500 USDT before some expiration date, say Jan 30th. For each unit of USDT s/he stakes in, two tokens are minted: a unit of claim token and a unit of unclaim token. The claim token holder, regardless of whether the holder being the insurer or a user who purchases the token from an insurer, has the right to sell one unit of ETH at a cost of 500 USDT before the expiration date, Jan 30th. On the other hand, the unclaim token holder can take the underlying token USDT staked in the platform after expiration in case the claim token is never exercised.

The example illustrates several facts of the decentralized insurance system. The value of the underlying token is equivalent of the sum of the claim token value and the unclaim token

value. This is true because using the combination of a unit of the claim token and a unit of the unclaim token can exchange back the staked underlying token at any time. The value of the claim token drops to zero immediately after expiration and the value of the unclaim token equals the value of the underlying token.

There are potentially many users purchase claim tokens with the same characteristics (exchange rate, date of expiration, etc). At the expiration date, some claims may have been exercised while others are not. This means a portion of the claims in the pool may have been exchanged from USDT to ETH, while others not. Therefore, the staked tokens the insurer takes back from the platform may not all be the same token. In the above example, it is possible that user 1 stakes in 1 USDT and the user who purchases his claim token has not exercised it before expiration. In that case, the insurer may not take back exactly 1 unit of USDT from the platform, but rather take back, say 70% USDT and 30% ETH. This rule in effect establishes a "risk-sharing" mechanism within the pool for the same claim token.

3 The decentralized insurance system

In a standard insurance contract offered by normal centralized insurance companies, funding for insurance payments are collected by various sources of insurance premiums. Since each individual customer may be exposed to various sources of risks, the insurance company is highly unlikely (or impossible) to encounter the situation where a significant portion of customers file a claim. In this way, the insurance company effectively serves a risk-sharing platform. In a peer-to-peer risk sharing mutual, a centralized platform such as an insurance company is no longer needed. Funding of insurance payments is collected from customers who wish to cover some of the risks and to make some investment profit from insuring.

3.1 Fundamentals

For all the insurances in the platform, a simple ERC-20 compatible token – ISM – will be created to serve as the key internal incentive mechanism to bind the mutual. ISM can be purchased at any time but at a viable price in the liquidity pool. This design is different from the usual ICO type approaches which aim at profiting from later speculative trades on exchange.

Unlike existing insurance platforms on the market, our platform does not require any price oracle. This is the case because the platform is in effect a token swap platform where the swap-

ing can happen anytime before expiration as long as the claim holders wishes to. Hence, there is no need to feed the system with current market data, hence, no price oracle needed. The only function the platform serves during each contract is to reassign the decision right of exercising the claim token, and faciliate token swaps. Similarly, since all existing insurance products are initiated by ISM holders, DAO governance is not needed at least at the product design level. See Figure 3.1 for the exact structure of flows on the ISM system.

3.2 Functionalities

When a user wishes to stake in some of token holdings and start to provide insurance and earn ISM as a reward, s/he can choose one of the stake pools that include the token s/he has. See Figure 3.2 for the interface for the users who wish to become insurance providers.

In the interface relevant information is provided, including the current rate of return for providing the insurance, the current size of the pool, the current strike price, and the current choice of insurance products. The user can either choose to mint claim and unclaim tokens by clicking the button or to return the unclaim tokens to retrack the tokens staked in the platform. See Figure 3.2.

As claim holders, they can always exercise before expiration and sell the tokens to the corresponding insurers. See Figure 3.2 for the interface of exercising.

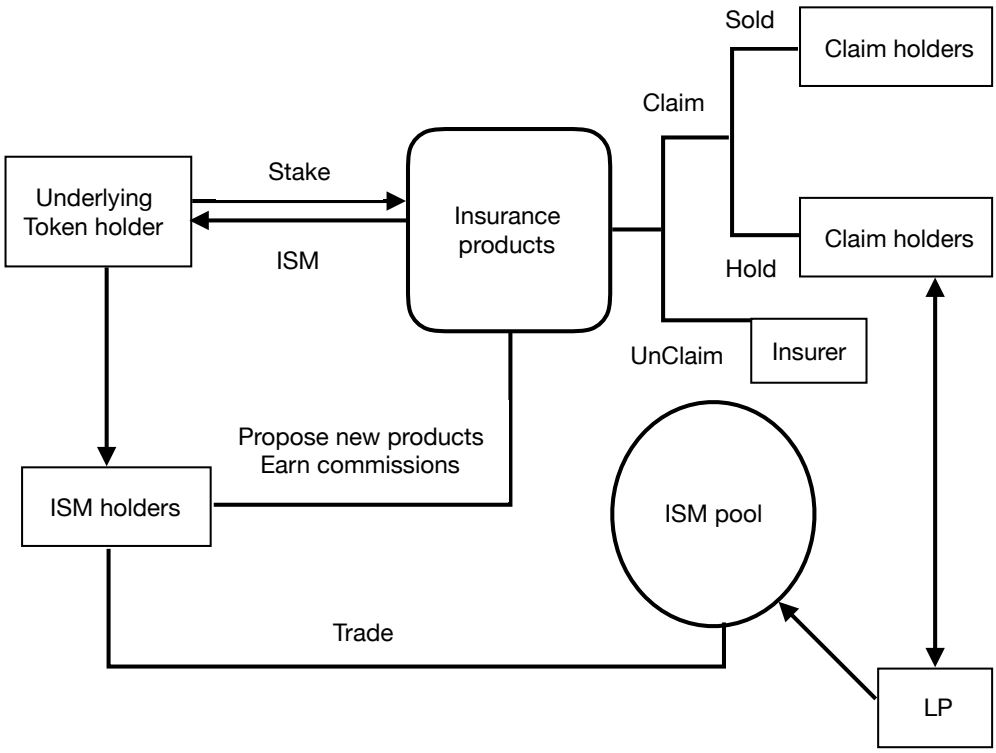
Claim holders may also trade claims in the pool of claims. The current price and other relevant information is provided in the trading interface given by 3.2. It is claim token liquidity providers faciliate the trade of claims.

4 Economic Model

4.1 Payoffs of participants

We summarize the payoff functions of each party below.

Insurer: Insurers bear the risks that claim holders exercise the claim and suffer a loss. To compensate the insurers, they have returns from several channels. First, they earn the fees from selling the claims. In the event that the claims are unexercised, they yield a return equals the price of the claims. In addition, insurers are compensated in ISM for their contribution


Sold
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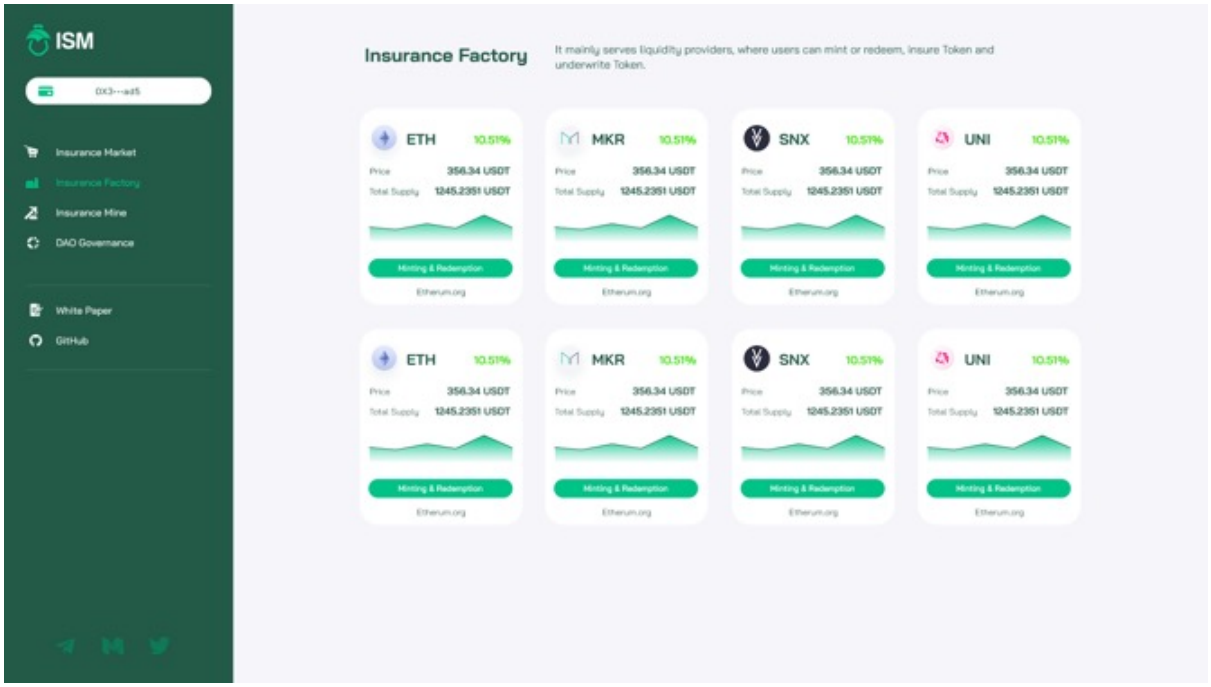
ISM
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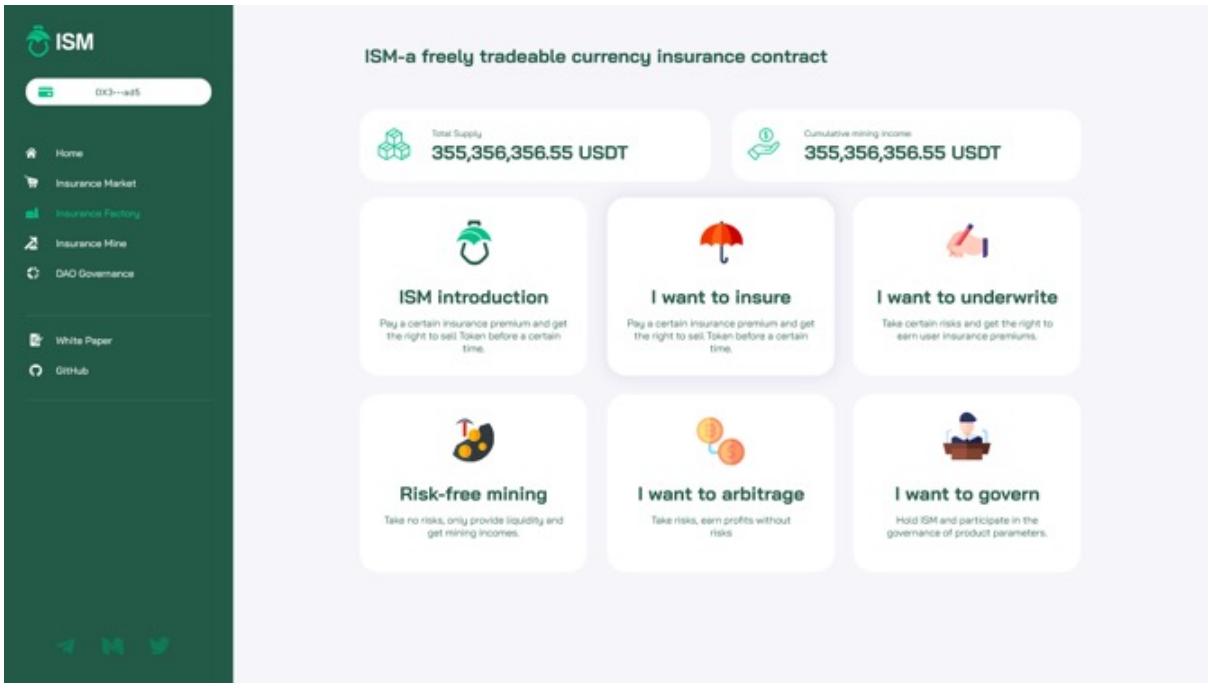
Insurance Market
Insurance Factory
Insurance Mine
DAO Governance
White Paper
GitHub
Insurance Factory
It mainly serves liquidity providers, where users can mint or redeem, insure Token and underwrite Token.
ETH 10.51%
MKR 10.51%
SNX 10.51%
UNI 10.51%
Price 356.34 USDT
Total Supply 1245.2351 USDT
Minting & Redemption
Etherum.org


ISM
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Home
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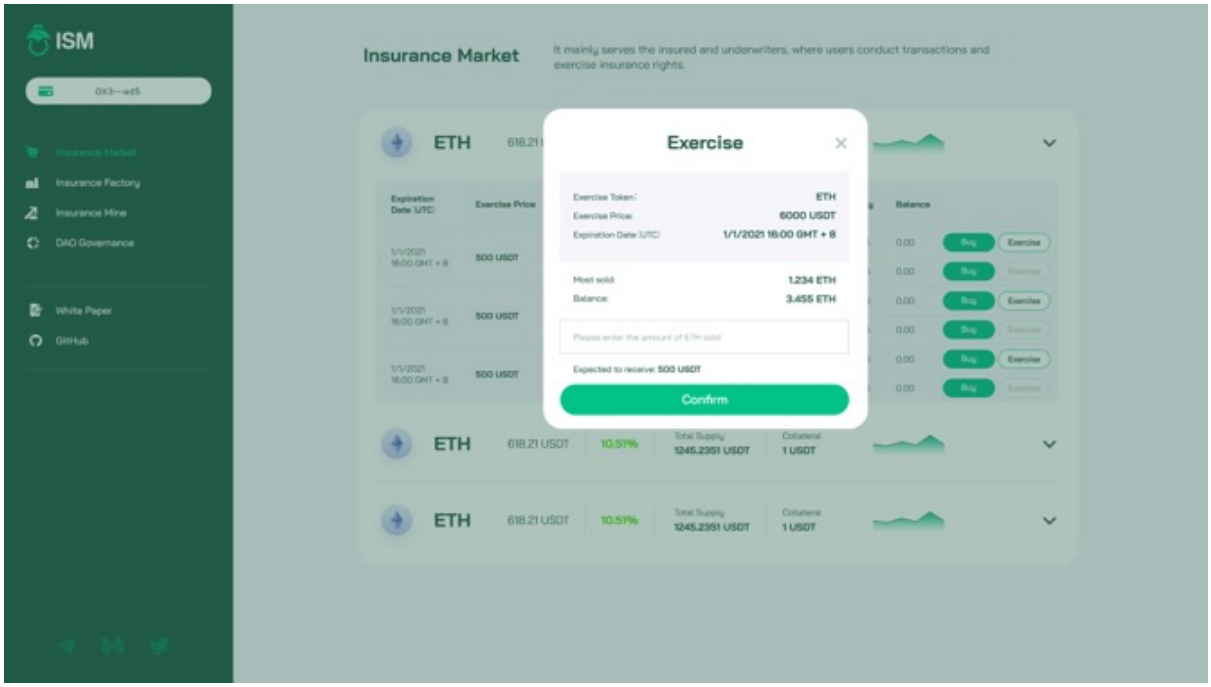
Insurance Factory
Insurance Mine
DAO Governance
White Paper
GitHub
ISM-a freely tradeable currency insurance contract
Total Supply
355,356,356.55 USDT
Cumulative mining income
355,356,356.55 USDT
ISM introduction
Pay a certain insurance premium and get the right to sell Token before a certain time.
I want to insure
Pay a certain insurance premium and get the right to sell Token before a certain time.
I want to underwrite
Take certain risks and get the right to earn user insurance premiums.
Risk-free mining
Take no risks, only provide liquidity and get mining incomes.
I want to arbitrage
Take risks, earn profits without risks
I want to govern
Hold ISM and participate in the governance of product parameters.


ISM
Insurance Market
Insurance Factory
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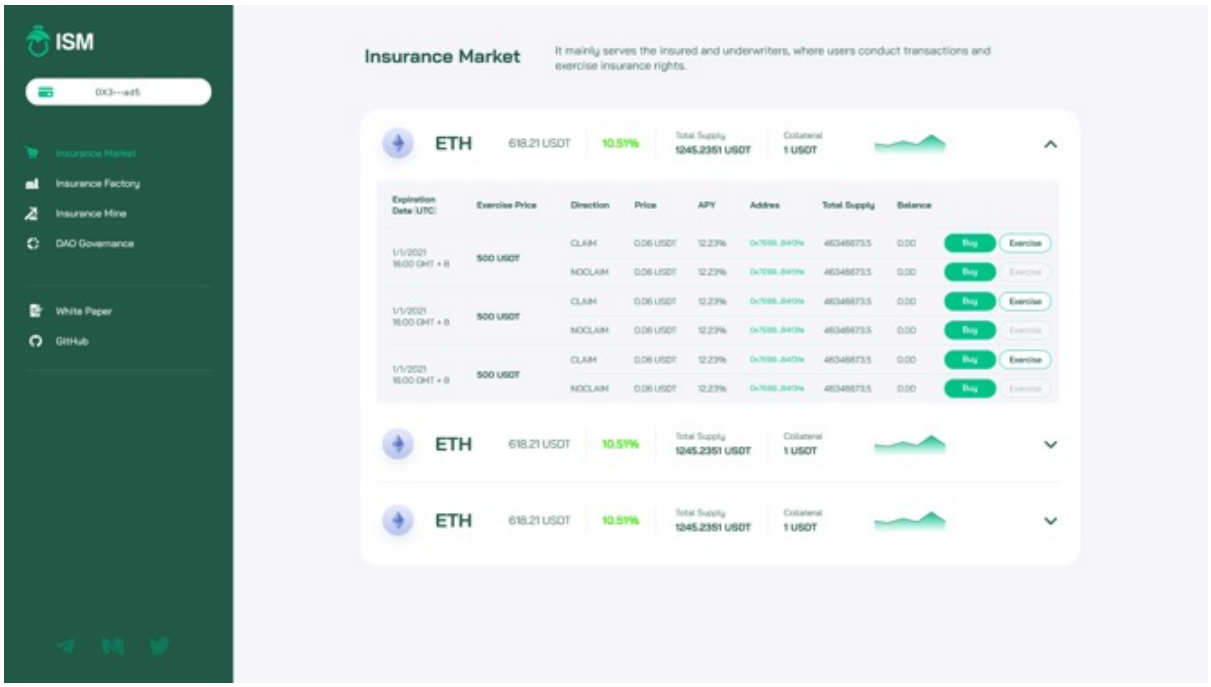
DAO Governance
White Paper
GitHub
Insurance Market
It mainly serves the insured and underwriters, where users conduct transactions and exercise insurance rights.
ETH
Exercise
Exercise Token:
ETH
Exercise Price:
6000 USDT
Expiration Date (UTC):
1/1/2021 16:00 GMT + 8
Most sold:
1.234 ETH
Balance:
3.455 ETH
Expected to receive: 500 USDT
Confirm
618.21 USDT
10.51%
Total Supply
1245.2351 USDT
Collateral
1 USDT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Insurance Market
It mainly serves the insured and underwriters, where users conduct transactions and exercise insurance rights.
ETH
618.21 USDT
10.51%
Total Supply
1245.2351 USDT
Collateral
1 USDT
Expiration Date (UTC)
Exercise Price
Direction
Price
APY
Addres
Total Supply
Balance
500 USDT
CLAIM
NOCLAIM
Buy
Exercise

to the platform by offering insurances. The platform guarantees that insurers obtain per insurance contract return of R amount in ISM. Finally, insurers also obtain an investment return from staking their tokens on the platform before the date of expire or the date that the claim is exercised. Denote by $r(t)$ the cumulative return from such investments at time t. Therefore, insurers' payoff can be written as

$$\begin{aligned} \pi^I(ue) &= [1 + r(T)]S_T + P_0 + R_0, \text{ in the event that the claim is not exercised, and} \\ \pi^I(e) &= P_0 + R_0 + r(t) \cdot S_t, \text{ in the event that the claim is exercised.} \end{aligned}$$

Denote by $G_t(\cdot)$ the cumulative distribution of the period t (where $t \leq T$) exchange rate of the underlying token that claim holders seek to protect. Then, the insurers' expected payoff can be written as

$$E_0(\pi^I) = P_0 + R_0 + [1 + r(T)]E_0(S_T)\prod_{t=0}^{T}[1 - G_t(K)] + \left[1 - \prod_{t=0}^{T}[1 - G_t(K)]\right] \cdot E_0(S_t \cdot r(t)),$$

where K is the strike price and $E_0(\pi^I)$ denotes the period-0 expectation of the payoff. An insurer decides whether to stake some tokens in the platform by comparing the expected payoff from doing so and the payoff of holding the underlying asset. At the optimal, the insurers choose to stake-in if π^I is sufficiently large compare to the period-0 expected price of the underlying token $E_0(S_t)$.

It is then obvious that the price of the claims, the return from staking, and the return from staking in the smart pool (or valut), the distribution of the underlying token price all affect the insurers' willingness of staking. In general, a token holder expects the token price to go up would prefer to offer insurance on the platform, whereas a token holder expects the price to go down would seek for protection by purchasing a claim.

Claim holder: A token holder may have incentives to purchase cover for the holdings when s/he expects that the token price might go down. The expectation is often not too strong as in that case s/he would better off selling the tokens. The cost of purchasing a claim and becoming a claim holder is simply the price paid at time 0, P_0. The benefit, on the other hand, depends on whether the time comes and the token price drops below the strike price and the holder wishes to exercise the option. The other part of the benefit is from trading the claims on the secondary market or to provide liquidity for claims on the platform. Selling the claims yields the difference between the price of purchasing and selling the claims, whereas providing liquidity yields

returns from liquidity mining. The instantenous value of a claim at time t is given by $\widetilde{P}_t = \max(K - S_t, 0)$, as by definition, the claim is in effect a put option that grants the holder the right to sell an asset at a prespecified price (strike price). However, the actual price of the claim is not equal $\widetilde{P}_t$, but must be rather calculated using the Black-Scholes formula, or simulated using Monte Carlo method. See Section 4.2 for details of pricing the claims. The return to liquidity mining is illustrated in the next paragraph.

Liquidity provider: There are two kinds of liquidity providers in association with the ISM insurance platform. The first kind includes the liquidity providers who are initially claim holders. Once they have purchased claims, they may decide to stake-in the claims into a claim pool provided by the platform to provide liquidity to those who wishes to purchase or sell claims. In other words, they serve as liquidity providers in the market of claims. Being the liquidity providers involves suffering losses from slippery, and hence, they need to be compensated for the losses or incentivized to stake-in their claims. Alternatively, the other kind of liquidity providers is those who provide liquidity to the ISM market. Recall that insurers are compensated with ISM for their contribution to the platform by offering insurance. They may wish to sell the ISM instead of issuing new insurance products. In addition, the market for ISM requires a market price that faciliates pricing and value transmission. Hence, ISM holders may wish to become liquidity providers on the secondary market of ISM. Again, doing so would cause some slippery losses and they must be compensated and rewarded for contributing to the price revalation in the ISM market. Returns to liquidity providers are obtained from liquidity mining. Another ERC-20 token, LPtokens, is obtained after becoming liquidity providers.

The platform: The returns to the platform come from two different sources. Once the insurers have stake-in the underlying tokens in the platform, the internal valut starts to operate the funds to gain investment returns. Recall that the insurers are able to make a return from these investments. The total investment returns will be allocated between the platform and the insurers, and the specific allocation of the proceedings from the investment can be adjusted based on situational factors. For example, when it is believed that insurers must be provided with greater incentives to be able to offer insurances, greater share of the investment returns should be allocated to them.

The other part of the returns to the platform comes from commissions obtained once insurers stake-in some underlying tokens and mint the claim tokens. Minting claim tokens incurs a 2% commission. In particular, by staking in an amount F of underlying tokens to mint 1 unit

of claim token and 1 unit of unclaim token, the insurer can sell the claim token to make an earning. At the time of expire, suppose the claim is not exercised or the insurer holds both the claim and unclaim token, s/he can take back 98% of the stakes from the platform.

4.2 Pricing of Claims

In effect, the claim is equivalent of an American put option with a strike price specified by the insurer at the time s/he stakes in on the platform. It is a put option because a holder of the claim can exercise the option by selling some tokens to the insurer at the strike price. The fact that the option holder can sell it anytime before expiration date suggests that it is an American instead of an European option.

There are multiple methods of pricing American options. It is well-known in the mathematical finance literature that American options do not have a closed-form solution. Researchers and practitioners can at best approximate the price. The most popular numerical methods to evaluate American options include the method based on the celerated Black-Scholes formula and Monte Carlo. Here, we provide an example of the insurance claim and the pricing of the claim based on either methods.

The Black-Scholes PDE describes the evolution of any derivative whose underlying asset satisfies the Black-Scholes assumptionsm and can be used to price American options. In the current context, the underlying asset is the token that the insurer stakes in and the derivative is the Claim, which can be sold by insurers in the market. The Black-Scholes PDE for American option is given by:

$$\frac{\partial V}{\partial t} + \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + (r-q)S\frac{\partial V}{\partial S} - rV \leq 0$$

where

S: the underlying asset price, or the price of the token that the insurer stakes in;

V: the price of the Claim token as a function of time and the underlying asset price;

σ: the volatility of the underlying token price;

r: the continuously compounded risk-free interest rate;

q: the mining return in the pool of staking;

t: the time in years.

Solving for the formula under the boundary condition for the American put option:

$$P(S,T) = \max(K - S, 0), P(0,t) = S, P(S \to \infty, t) = 0$$

where

T: the expiry time

K: the excercise price

P: the price of the Claim token.

Since American options can be exercised at any time, we must add an extra condition at each point on the grid to verify if it is optimal to do so. Therefore, there is an extra verification for the put option

$$P(i,j) = \max(K - i\Delta Z, P(i,j)).$$

Given that the claims can be priced as such, we simulate the price of the claim tokens in the following example.

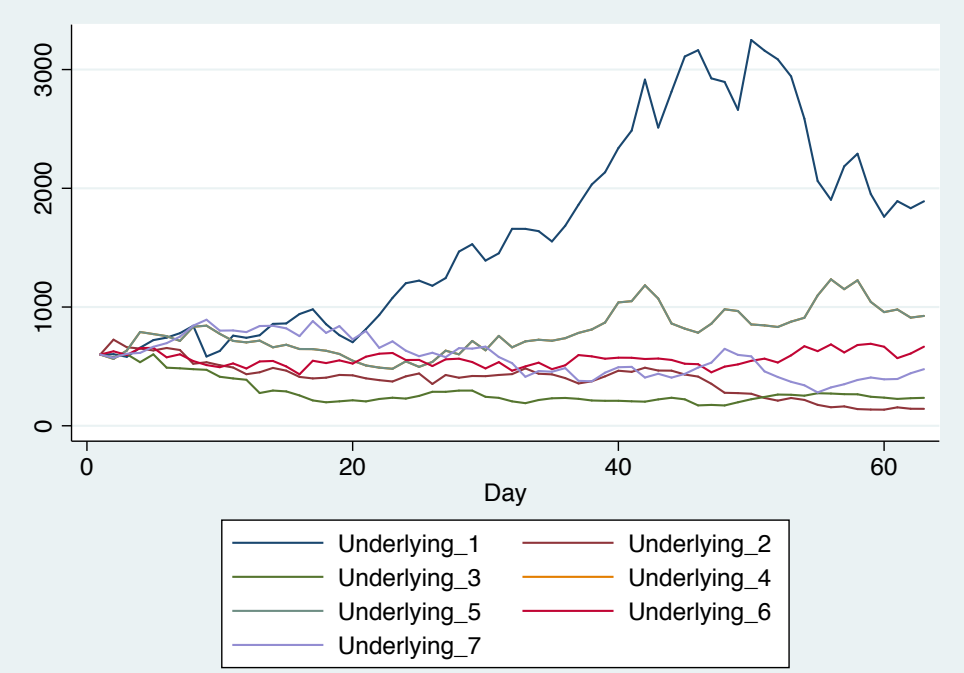
Example 1. *Suppose the underlying token's initial price is 500 USDT. Then, the claim token with a strike price of 600 USDT may exhibit different historic path. Here, we provide seven different simulations to illustrate the possible claim and unclaim token prices. Figure* 1 *illustrates the Monte Carlo simulations of the underlying token price. Given the underlying token prices simulated, we can find instantaneous value of the claim token, which then can be used to calculated the path for the value of the claim. See Figure* 1 *below.*

Correspondingly, the value of the unclaim token can be obtained in Figure 1.

5 Summary

The platform offers an opportunity for all users to purchase, provide, trade insurances of token prices. The platform issues a new token ISM to reward contributors on the platform. The total amount of ISM is 60,000 units and will be allocated within 60 days. The future compensation and rewards to be paid to contributors are funded by the platform's return. The initial allocation of ISM covers all potential participants.

We summarize the main special features of the ISM system: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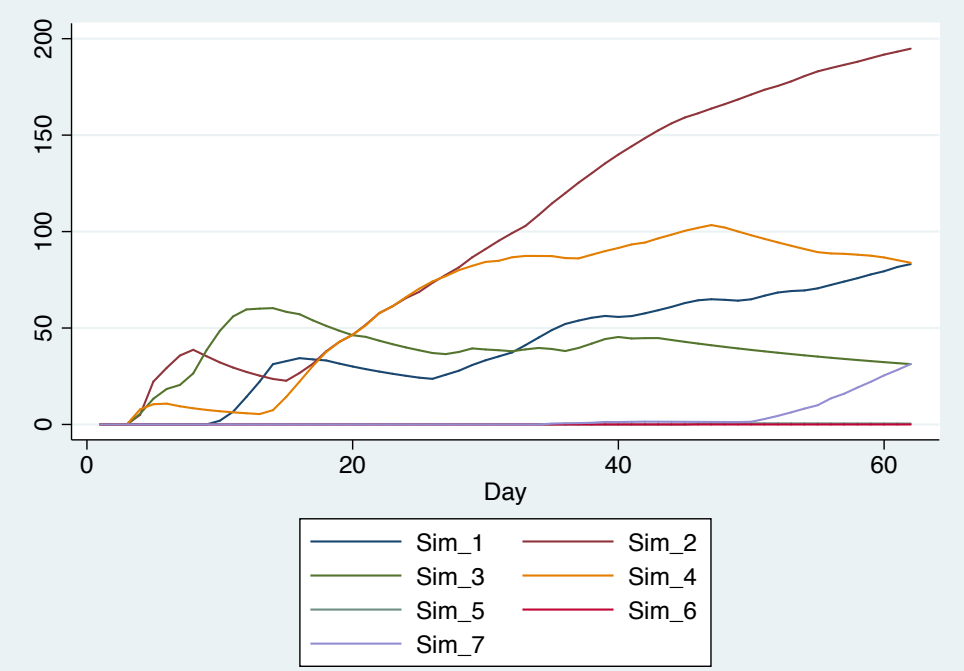
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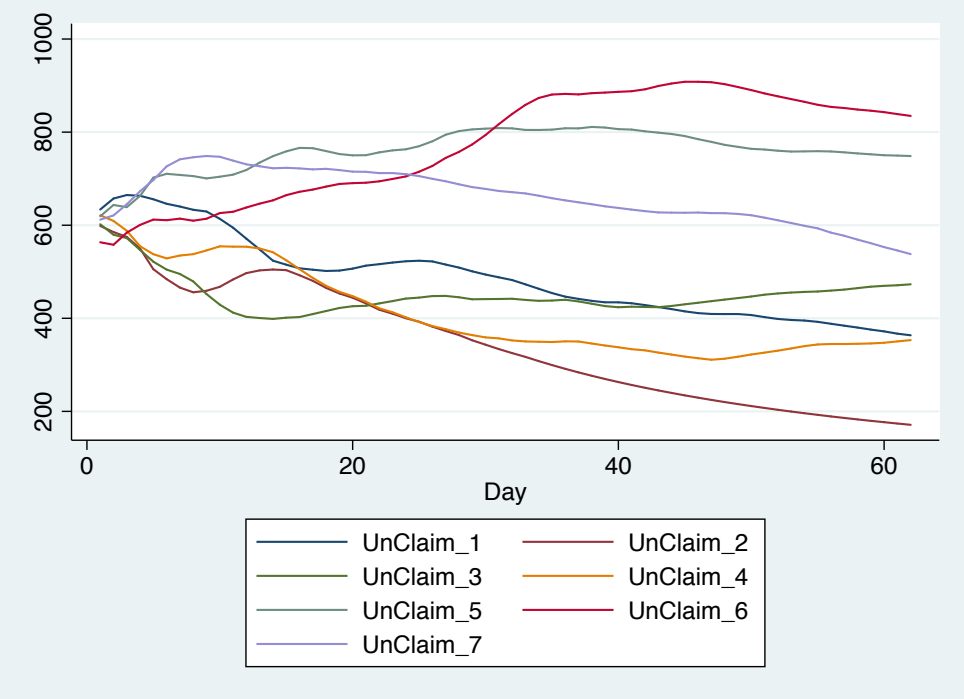

- ISM holders are able to burn ISM at hand to initial new insurance products from which they can earn a cut of commission.
- Insurers are able to obtain a return of investment from the tokens they stake on the platform to mint claims.
- Liquidity providers, including those provide liquidity in the claims market and the ISM market, are rewarded for their contribution in LPtokens.

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