

Tropykus Finance Protocol

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1 Introduction

Tropykus Finance offers simple digital lending, borrowing, micro savings and microloans products, focused on emerging economies such as Latin America. We seek to incentivize anyone who owns Bitcoin and USD stable Tokens to use the protocol to obtain passive returns while at the same time providing Latin Americans access to fair loans. To achieve this, we leverage the strengths of DEFI (Decentralized Finance): total control over your funds, your privacy, better savings interest rates compared to money markets, and provide lower interest rates on loans compared to what Latin Americans can find in local banks. We strive to become an alternative to the traditional financial system and promote change in developing countries; starting in Latin America.

Tropykus is a decentralized lending protocol on top of Bitcoin (i.e. second layer compatible with the Ethereum Virtual Machine EVM: RSK) inspired by Compound and Aave protocols. These lending protocols provide a decentralized marketplace for suppliers and borrowers holding crypto assets. Tropykus provides alternative deposit and lending smart contracts for users with different interests in terms of return expectations and investment horizons, with similar risk management features of other lending protocols (e.g. collateralization, liquidation incentives). It also provides markets and accepts as collateral alternative crypto assets such as rBTC, RIF, rUSDT, DOC. In this document, we make frequent reference to existing lending protocols, in particular Compound, to present to the community the difference between Tropykus and existing protocols.

The objective of this document is to provide a general vision of Tropykus as a project, an overview of the financial characteristics of the marketplace, and its relation to the smart contracts that support the protocol. This document is organized as follows: Section 2 describes Tropykus project. Section 3 provides a detailed description of the financial principles for crypto assets and fiat-currency-pegged stable coins (e.g. participants, interest rate model) and the market dynamics. Section 4.1 gives a high-level introduction to the technology and smart contracts.

2 Tropykus Project

Tropykus identifiable characteristic is the reference to the part of the world where most of the developing countries are geographically located. At the same time is where all of us want to live, because in the Tropykus life is great. We aim to offer this greatness in financial life as well.

Latin Americans search for alternatives to save and borrow money. However, traditional financial institutions in this region have financial intermediation margins that are significantly higher than in more developed countries. Bitcoin brought a new paradigm: a currency that has no borders or government control. A strong currency that instead of losing value by inflation, has a fixed supply, fully backed by math and strong cryptography. We believe in Bitcoin as a store of value and we take advantage of it to provide fairer conditions for financial consumers than traditional banking.

Tropykus is born as a platform for Bitcoin and USD stablecoin holders to become agents of change. The protocol will not only facilitate returns on these assets while at the same time providing liquidity and better conditions for Latin Americans for savings and microloans. Tropykus aims to unleash the potential of Bitcoin to benefit everyone in developing economies.

We want to offer new financial possibilities, more accessible and fair alternatives to the traditional banking system. Why do savings have almost zero annual interest rate while loan rates are up to 20% in the best cases? How many people face restricted access to loans to better their lives by investing in education, properties and businesses? How many of us have

been turned down in a loan application? Even if we manage to receive the loan we end up paying twice as much as the initial value, due to high interest rates!

Some Latin Americans have suffered from the devaluation of their local currencies. Venezuela and Argentina are the extreme cases in the region, but almost all the Latam currencies lose value against the USD and Euro in the long run. Of course, poorer households, who can not access traditional markets, are more susceptible to losing purchasing power with respect to the goods and services offered throughout the world.

Unlike ether holders, bitcoin holders have a lack of alternatives to yield their BTC and stable coins, without losing control of their funds and protecting their privacy in a noncustodial manner. We believe that the people that are starting to use bitcoin on a day-to-day basis and have small amounts are the people that need the most savings options of their assets, that's why we have proposed a social micro saving service to create incentives through cryptoassets.

2.1 How are we going to reach regular people

Bridges with local currencies through on ramps¹ and off ramps² to give ordinary people access to savings with digital assets that do not devalue against the dollar is part of Tropykus vision. As for the loan, at the first stage and as with similar protocols, these loans will be collateralized. In a second stage, we will offer mechanisms to score debtors based on repeated interaction with the protocol, collateral delegation and partnerships with foundations in the crypto space interested in financial inclusion.

An easy user experience that does not require technical knowledge about cryptocurrencies and blockchain to use our saving and credit services is key for Tropykus' users. Over time, our users will only need the average knowledge to navigate a website to improve their financial status and improve their quality of life.

This is the Tropykus vision. If you are from Latin American, you will understand it, given the region's difficulty in providing access to cost-effective financial services. We seek to have financial products that are fairer and more accessible to people, using Bitcoin blockchain technology as the means. We want Latin Americans to have better opportunities and financial security, thereby becoming an alternative to the current banking system which is perceived as benefiting a minority and providing limited access to the rest. Join us in Tropykus to get returns on your bitcoin and create new opportunities.

3 Financial principles of the protocol

The essence of a decentralized lending protocol is to provide proper incentives for the participants. The **suppliers** are the fundamental participants since by depositing cryptoassets they provide liquidity to the protocol, these resources support the intermediation activities of the protocol. Any user who wants to participate in the protocol is a supplier; most users deposit to receive profit for the liquidity provided. **Borrowers** use the liquidity provided as collateral, this allows this kind of user to borrow assets on the different markets of the protocol. The **protocol sponsors** and initial administrators provide an initial investment and bootstrap the market with an initial control over parameters and primitives. Once the protocol matures, a **governance** model is proposed to give participation to the users and the community. The protocol sponsors and, later, the governance, are by design responsible for the alignment of incentives and risk management. As in most decentralized protocols oversight on the value of the collateral and its relation to the loans is delegated to the **liquidators**.

3.1 Collateralized loans

The protocol will allow borrowers to borrow against their collateral in amounts greater than the cost of gas. Amounts below can not be borrowed. The rationale for this is to avoid getting small loans that can be prone to enter into the liquidation zone that won't be even close enough to cover gas costs.

Since decentralized lending protocols are anonymous markets, meaning that participants do not need to know each other or have information regarding their counterparts, all loans must be collateralized. Even in traditional financial, exchanging collateral is a mechanism to mitigate counterparty risk and has become a requirement and a standard for capital markets after the 2008 financial crisis.

Note: We are investigating other collateral mechanisms to facilitate access for those who do not have collateral, such as delegated collateral or reputation systems.

To get a loan, a borrower has to provide liquidity using accepted cryptoassets. These assets are exchanged for the protocol's **kTokens** (e.g. kUSDT, kDOC, kRIF, kRBTC) based on a reference exchange rate. **kTokens** are explained in more detail in section 3.1.1.

¹A cryptocurrency on-ramp refers to an exchange or similar service where you can offer fiat money in return for cryptocurrency. Source: Cryptocurrency On-Ramps and Off-Ramps, Explained

²Cryptocurrency off-ramps act as just the opposite of on-ramps. They are a way to convert your cryptocurrency into fiat, or possibly products and services. Source: Cryptocurrency On-Ramps and Off-Ramps, Explained

Accepted collateral in the form of a cryptoasset may vary depending on the volatility of its price, therefore the protocol defines a **collateral factor**. If a borrower collateralizes a volatile asset, the protocol will allow them to borrow less from the liquidity pool of the target borrowing market, whereas more stable assets allow them to borrow more of the target borrowing market (for the same amount of collateral). For example, stable coins like rUSDT and DOC, which are pegged to a fiat currency are by definition less volatile³.

The following is the scenario for a borrower collateralizing some of their kTokens ($kTk1$, and $kTk2$) to be able to borrow some coins right away from the liquidity pool of a given target borrowing market. Let's suppose the $kTk1$ is more volatile, whereas the $kTk2$ is more stable. Thus, the $kTk1$ will get a $collateralFactor = 0.5$, and the $kTk2$ will get a $collateralFactor = 0.75$. In other words, if the user wants to borrow, let's say 1000 USD, he will need to collateralize the equivalent of 2000 USD worthy on $kTk1$ tokens (i.e. $1000 \cdot \frac{1}{0.5}$), whereas he will have to collateralize equivalent of 1333.33 USD worthy on $kTk2$ tokens (i.e. $1000 \cdot \frac{1}{0.75}$). The example shows how the protocol accounts for the higher risk of more volatile assets.

3.1.1 kTokens

Every time a supplier deposits crypto assets into a market, the protocol internal process converts the amount to deposit into a determined amount of kToken. Tropykus protocol kTokens are kRBTC, kRIF, kUSDT and kDOC. The markets with JumpV2 ((1b)) and WhitePaper (1a) interest rate models (described in section 3.2) depend directly on the value of the exchange rate, explain in more detail in section 3.4. kTokens will represent user earnings on the market: because when a user wants to withdraw their deposits, the protocol internally calculates back how much of the underlying cryptocurrency it should be returned to the user. This calculation is done by dividing the amount of kToken user holds per the exchange rate shown in equation 1. The exchange rate will be slowly increasing. This way the result of the withdraw will be the initial amount plus some earnings. Let's see an example

Initially, the exchange rate value is 0.02. If a user deposits 100 DOC on DOC market, the protocol calculates the equivalent in kDOC, like this:

$$kTokens = \frac{underlying}{exchangeRate} \quad (1)$$

$$kDOC = \frac{100DOC}{0.02} \quad (2)$$

$$kDOC = 5000 \quad (3)$$

Therefore the user will receive on their wallet 5000 kDOC. Let's assume some time has passed, the exchange rate is now 0.0215 and the user wants to withdraw all their DOC from the market, so the protocol multiplies kDOC amount per exchange rate, to get DOC equivalent denominated as underlying. As shown below:

$$underlying = kTokens * exchangeRate \quad (4)$$

$$DOC = 5000kDOC * 0.0215 \quad (5)$$

$$DOC = 107.5 \quad (6)$$

Hence the user will receive on their wallet 107.5 DOC, so the interest earned from the initial 100 DOC is 7.5 DOC. The kToken price will increase in value as a function of the interest accumulation due to the loan's interest paid by borrowers.

3.1.2 Borrowing capacity

To be able to compute the borrowing capacity, we identify the n cryptoassets, accepted as collaterals that the borrower holds in the protocol. The protocol obtains information on the current price of the cryptoassets in USD. This information is obtained from an oracle (see section 3.6).

First, the protocol obtains the collateral amount supplied by any borrower in USD as,

$$totalCollateralInUSD = \sum_{Mkt=1}^n (collateralInUSD_{Mkt} \cdot collateralFactor_{Mkt}). \quad (7)$$

Secondly, the protocol obtains the current debt the borrower in USD as,

$$totalBorrowsInUSD = \sum_{Mkt=1}^n (mktPriceInUSD_{Mkt} \cdot borrowBalance_{Mkt}) \quad (8)$$

³As long as the peg is a credible one.

Finally, the protocol compares both values. If $totalCollateralInUSD > totalBorrowsInUSD$, the protocol computes the **borrowing capacity** as,

$$totalBorrowingCapacity = totalCollateralInUSD - totalBorrowsInUSD \quad (9)$$

Additionally, if $totalCollateralInUSD < totalBorrowsInUSD$ we will say that the borrower's account is in deficit, and they cannot borrow unless they collateralize more collateral or pays their loans. In such a case, the protocol calculates the deficit as

$$shortfall = totalBorrowsInUSD - totalCollateralInUSD \quad (10)$$

The protocol sponsors and, later, the governance will be able to pause a collateral market, forbidding borrowers to collateralize in that market and take our further loans. However, borrowers that have already collateralized in those paused markets will be able to withdraw their collateral at any moment as long as they have no active loans.

Note: All the markets, despite holding the actual value transferred from their underlying assets, will handle 18 decimals for internal operations.

3.2 Interest rate models for cryptoassets

Tropykus considers two types of interest rate models for the cryptoasset markets. In the first model, there is an explicit return target for suppliers that guarantee to return a minimum interest rate over the investment for micro-savings and microloans. This minimum interest rate in the Hurricane interest model and is denoted as the **Minimum Interest Rate** (MIR). In the second model, there is no minimum interest rate and hence suppliers are rewarded base on an observed borrow rate scaled by the utilization rate. This is analogous to the supply rate defined in Compound and similar protocols like Aave. This is an important difference on the Tropykus protocol in terms of committing a target return for suppliers.

Both models share some definitions and dynamics but have important variations that will be pointed out in each of the following sub-sections.

The forces of supply and demand in each market determine the utilization rate of the asset,

$$UR_{Mkt} = \frac{totalBorrows_{Mkt}}{totalCash_{Mkt} + totalBorrows_{Mkt} - reserves_{Mkt}} \quad (11)$$

where the total borrows and supply denotes the outstanding stock of loans and deposits denominated on the base currency: the cryptoasset. If there is more (less) demand on loans for this particular market then the utilization increases (decreases). By definition, the utilization rate is bounded to,

$$UR_{Mkt} \in [0, 1] \quad (12)$$

(see the section 3.3).

3.2.1 Borrowing in the protocol

For volatile markets such as RIF or rBTC, the **Borrow Rate** (BR) is a linearly increasing function of the utilization rate,

$$BR_{Mkt} = baseBorrowRate_{Mkt} + multiplier \cdot UR_{Mkt}, \quad (13)$$

In the case of stable markets such as DOC and rUSDT, the lending rate is described by a piecewise function, to provide lower rates for utilization rates below a *kink* defined by governance. The *kink* also provides a way to bring down utilization rates to their optimal level. In these protocols, high levels of utilization generate liquidity risks that need to be avoided.

The equation describes the way in which lending rates are calculated for stable markets.

$$BR_{Mkt} = \begin{cases} baseBorrowRate_{Mkt} + multiplier_{Mkt} \cdot UR_{Mkt} & , \text{ if } UR_{Mkt} \leq kink \\ baseBorrowRate_{Mkt} + multiplier_{Mkt} \cdot kink + jumpMultiplier(UR_{Mkt} - kink) & , \text{ otherwise} \end{cases} \quad (14)$$

where *kink* is a parameter defined by the administrator (later by governance), which indicates the utilization rate at which the slope is changed in the borrow rate calculation.

The reported **Borrow Rate** (BR) is annual, but the interest is accrued at every block, so the **Borrow Rate Per Block** is,

$$borrowRatePerBlock_{Mkt} = \frac{BR_{Mkt}}{blocksPerYear} \quad (15)$$

Note: The *borrow rate* will be used for the loans on this market and is not a function of the size of the loan.

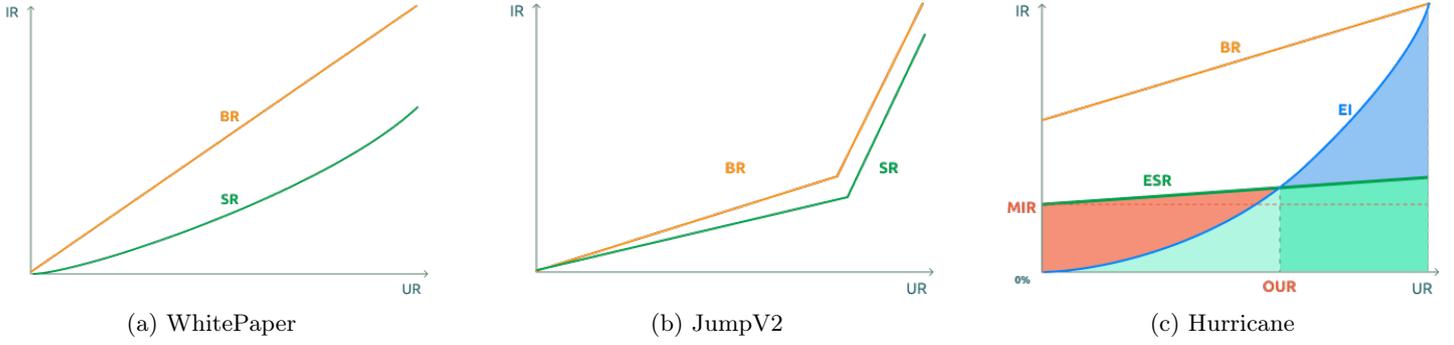


Figure 1: Tropykus Interest Rate Models

3.2.2 Lending in the protocol

As mentioned previously, the participants in the protocol (except the liquidators) must always supply resources and if they want to access loans they can use their liquidity as collateral. All the markets in Tropykus will use an Interest Rate Model, the interest rate model determines how each market's supply and borrow rates will behave, this is described in figure 1.

3.2.3 Hurricane Interest Rate Model

Depositors obtain an **Expected Supply Rate** (ESR). Unlike other protocols, this expected rate has a MIR return starting at a floor rate that increases slowly and linearly as a function of utilization,

$$ESR = MIR + supplyRateSlope \cdot UR, \quad (16)$$

where MIR is the **Minimum Interest Rate**. This linear model for the expected Supply Rate Provides a mechanism to target specific minimum levels of interest rates for depositors. This is a key difference from what is currently offered in other lending protocols.

If we analyze the rate of return for protocols such as Compound, we can see that this rate is only a portion of the interest paid by the borrowers,

$$supplyRate_{Compound} = BR \cdot UR \cdot (1 - reserveFactor) \quad (17)$$

$$interestToReserves_{Compound} = BR \cdot UR \cdot reserveFactor \quad (18)$$

where $reserveFactor \in [0, 1]$ is a parameter defined by governance.[1]

Therefore, it can be stated that the percentage of interest that is being paid into the protocol is given by the following expression

$$EI = supplyRate_{Compound} + interestToReserves_{Compound} = UR \cdot BR \quad (19)$$

At Tropykus we believe that a linear function for both the lending rate and the ESR supply rate provides a transparent way to guide the return on investment for depositors. However, it is also a challenge to finance a subsidy fund to guarantee the effective interest margins necessary to make the protocol financially sustainable over time or as a capital reserve in case of under-collateralization.

The reported Expected Supply Rate ESR are annual, but the interest is accrued at every block, so the **Supply Rate Per Block** is,

$$supplyRatePerBlock = \frac{ESR}{blocksPerYear} \quad (20)$$

Note: For markets that have the supply rate from WhitePaper(1a) or JumpV2(1b) interest rate models, the supply rate per block is calculated in the same way as in equation 20.

The Supply Rate SR , as well as the Borrow Rate BR , will change upon users' actions. Those actions can be understood as a change in the supply and demand ratio, or, the utilization rate (i.e. UR).

In the Tropykus Hurricane Interest Rate Model, the protocol pays depositors using the linear supply curve (i.e. ESR), but considers the quadratic supply curve as the benchmark for funding reserve funds (i.e. EI) as shown in Figure 2. The intersection between the linear function of Expected Supply Rate and the quadratic function of Supply Rate provides an

Optimal Utilization Rate (i.e. OUR). This Optimal Utilization Rate is a parameter that determines the level at which the reserve fund receives resources as a function of the interest rate model. Appendix 6.1 explains how the Optimal Utilization Rate is determined.

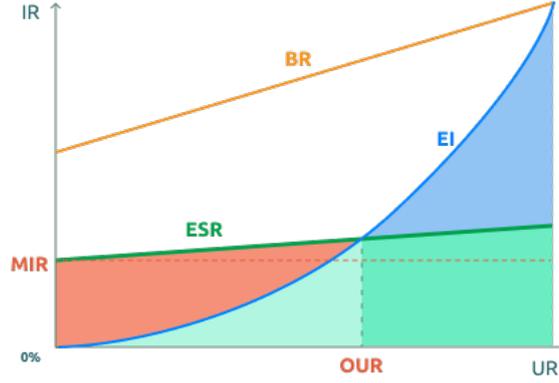


Figure 2: Hurricane Interest Rate Model. Where BR denotes the Borrow Rate function, ESR the Expected Supply Rate function, MIR the Promised Base Return Rate (intercept of ESR), EI is the quadratic Supply Rate function, OUR is the Optimal Utilization Rate.

In Figure 2 The Utilization Rate above the Optimal Utilization Rate $UR > OUR$ implies that part of the accrued interest paid to depositors will be set aside to increase the reserve fund of the market(s) with the Hurricane model. Since the MIR supply rate is, by design, almost certainly higher than that of competing protocols, the protocol requires maintaining it at a certain level. Depending on the financial sustainability of the protocol, the base MIR rate of return will be adjusted, initially by the protocol sponsors and later by governance.

3.3 Monetary aggregates and market dynamics

A decentralized lending market for a particular cryptoasset is a self sustainable money market. The monetary aggregates use as unit of account (measurement of value) the cryptoassets⁴ and must comply with the following monetary identity:

$$totalSupply = totalCash + totalBorrows - reserves \quad (21)$$

where $totalCash$ is a construct that reflects the disposable liquidity. However, the available liquidity or liquidity pool excludes the reserves. Therefore,

$$marketLiquidity = totalSupply - totalBorrows, \quad (22)$$

and hence $totalCash = marketLiquidity + reserves$.

Note: In the case of markets that have a Hurricane Interest Rate Model, the $totalSupply$ will be calculated as:

$$totalSupply = totalCash + totalBorrows - reserves - subsidyFund \quad (23)$$

If we denote as t the block time, then the current stock of total borrows is given by,

$$totalBorrows_t = totalBorrows_{t-1} \cdot (1 + borrowRatePerBlock_{t-1} \cdot \Delta Blocks) \quad (24)$$

where $\Delta Blocks$ is the gap between state changes in the protocol (i.e. borrowing, repaying, paying all the debt, withdrawing, supply, or liquidation dynamics). This implies that the new stock of borrows incorporate the accrued interest estimated by the $borrowRatePerBlock$ updated by the interest rate model every time there is a new utilization rate.

3.3.1 Withdraw

Borrowers will be able to withdraw their cryptoassets from a given market by exchanging kTokens using the current block exchange rate (see 3.4 for more information).

The protocol will perform actions to ensure the borrower can withdraw their collateral, thus avoiding affecting the current loan, if any, by entering into the liquidation zone. The protocol will consider the $TotalCollateralInUSD$ (equation 25) and the $TotalBorrowsInUSD$ (equation 26).

$$TotalCollateralInUSD = \sum_{Mkt=1}^n kTokensBalance_{Mkt} \cdot exchangeRate_{Mkt} \cdot collateralFactor_{Mkt} \cdot priceInUSD_{Mkt} \quad (25)$$

⁴This means that all relevant monetary aggregates are in units of the cryptoasset accepted as collateral

$$TotalBorrowsInUSD = \sum_{Mkt=1}^n borrowBalance_{Mkt} \cdot priceInUSD_{Mkt} \quad (26)$$

Once the basic calculation is done, the protocol considers the side effect of withdrawing a certain amount of kTokens on the borrows side,

$$borrowWithEffects = TotalBorrowsInUSD + kTokensToRedeemInUSD \quad (27)$$

once again, the protocol defines the *TotalBorrowingCapacity* and the *Shortfall*, but this time considering the side effect of the withdrawing on the borrowing side.

$$TotalBorrowingCapacity = TotalCollateralInUSD - borrowWithEffects \quad (28)$$

$$Shortfall = borrowWithEffects - TotalCollateralInUSD \quad (29)$$

If the $TotalCollateralInUSD > borrowWithEffects$ there is enough liquidity to perform the withdraw, otherwise, the loan would be in a shortfall, and the withdraw wouldn't be performed.

The borrower will be able to withdraw if there is enough cash in the liquidity pool and the amount of liquidity pool kTokens to be exchanged,

$$withdraw = \min(liquidityPoolBalance, amountToBeWithdraw) \quad (30)$$

3.3.2 Reserves

The reserves aim to promote the safe development of the protocol and to be used in the occasion that liquidators can't get into the undercollateralized loan fast enough or are not willing to liquidate a position. In the latter, this creates an undercollateralized position where the current collateral does not cover 100% of the loan. This fund is known as a reserve fund for the risk associated with undercollateralization.

Reserves will accumulate as a function of the accrued interest in every block for a given market. In other words, reserves will be increased due to the loans and the interest accrued by the borrowers,

$$reserves_{t,Mkt} = reserves_{t-1,Mkt} + totalBorrows_{t-1,Mkt} \cdot \DeltaBlocks \cdot borrowRatePerBlock_{t-1,Mkt} \cdot reserveFactor_{Mkt} \quad (31)$$

where *reserveFactor* is a parameter defined by governance in the case of markets with Compound legacy models.

For the case of markets with the Hurricane Interest Rate Model, the calculation for the reserves is given by the equation 32

$$reserves_{t,Mkt} = reserves_{t-1,Mkt} + RF_{t-1,Mkt} \cdot totalBorrows_{t-1,Mkt} \cdot \DeltaBlocks \quad (32)$$

with,

$$RF_{t-1} = \begin{cases} 0 & , \text{ if } UR \leq OUR \\ EI_{t-1} - ESR_{t-1} & , \text{ otherwise} \end{cases} \quad (33)$$

3.3.3 Subsidy

The subsidy fund will be an exclusive resource for markets with a Hurricane Interest Rate Model that aims only for micro-savings and microloans. The objective of this fund will be to subsidize the promised yields (ESR) to the suppliers. Equation 34 describes the state of the subsidy fund at state t.

$$subsidyFund_t = subsidyFund_{t-1} - SFfactor_{t-1} \cdot totalBorrows \cdot \Deltablocks \quad (34)$$

where,

$$SFfactor_{t-1} = \begin{cases} ESR_{t-1} - EI_{t-1} & , \text{ if } UR \leq OUR \\ 0 & , \text{ otherwise} \end{cases} \quad (35)$$

The protocol developer will provide an initial investment to this subsidy fund that will provide sufficient resources to guarantee the prime rate of return promised to suppliers in this market. Market dynamics and related utilization are expected to provide a stable source of resources to the fund over the medium term for the protocol.

Funds used to replenish the subsidy fund will be drawn from the reserves of the stable coin markets. This is expected to ensure the sustainability of the Social RBTC market.

3.4 Exchange rate in Tropykus

Suppliers will get kTokens in exchange for providing resources in the market that accepts a particular crypto asset as collateral. In lending protocols, these kTokens provide an alternative unit of account in the form of IOU⁵ that has a relationship to the unit of account of the crypto asset used as collateral. Therefore, when a supplier desires to enter a particular market, they supply the collateral to the pool and receives some units of the kTokens. The exact number is determined by the current exchange rate. In addition to a unit of account, the kTokens also provide a mechanism to reward the accrued interest to the suppliers as a function of the realized supplied rates and the respective accrued interest obtained during the holding period of the kTokens.

The kTokens' price will increase in value as a function of the interest accumulation due to the loan's interest paid by borrowers.

$$X_t = \begin{cases} X_0 & , \text{if } kTokensMinted_{t-1} = 0 \\ \frac{Cash_{t-1} + totalBorrows_{t-1} - reserves_{t-1}}{kTokensMinted_{t-1}} & , \text{otherwise} \end{cases} \quad (36)$$

where kTokensMinted is the amount of kTokens that have been minted in exchange for the deposits made in the market they represent. They can be 0 if all lenders decide to exchange their kTokens for tokens from the underlying market.

The value X_0 is arbitrary and predefined at the birth of the protocol as the number of units of kTokens for one unit of the crypto asset. In most protocols, the *borrowRatePerBlock* involves a very slow X_t incremental process, so it is very difficult for providers to get an accurate notion of the holding period returns obtained by supplying assets to the protocol and the liquidity pool before redeeming their kTokens.

In the case of markets with the Hurricane Interest Rate Model, we implemented an innovative method that guarantees the returns promised to suppliers.

When a user wishes to withdraw, the protocol automatically determines the returns to be paid to the user, via the supply rate at which the deposit was made (equation 37). Once the interest to be paid is determined, the protocol takes the current expected supply rate, along with the present value of the EI, and determines the interest rates coming out of both the pool and the subsidy fund (equation 38).

$$interestToPay_t = tokensSupplied_{t-k} \cdot supplyRatePerBlock_{t-k} \cdot \Delta blocks \quad (37)$$

Assuming that the user supplied at the time k .

$$SFP = interestToPay_t \cdot \frac{SFfactor_t}{ESR_t} \quad (38)$$

thus, the number of kTokens remaining in the user's possession is given by the following expression

$$kTokensAfterRedeem = \frac{tokensToRedeem \cdot kTokensBalanceBeforeRedeem}{tokensSupplied} \quad (39)$$

3.5 Liquidation

Liquidation is a dynamic that helps the protocol to provide liquidity in scenarios where there are loans that are at risk of becoming undercollateralized.

Each market has a *collateralFactor* that indicates the maximum a borrower is going to receive for the collateral that they post on the market. It is expected for borrowers to avoid borrowing up to the limit allowed because it makes them prone to be liquidated and face a penalty. Thus, the protocol provides a way to find a health indicator that helps the borrower and liquidators to know the borrower's health,

$$healthRatio = \frac{\sum_{Mkt=1}^n collateral_{Mkt} \cdot collateralFactor_{Mkt} \cdot marketPriceInUSDC_{Mkt}}{\sum_{Mkt=1}^n updatedBorrowAmount_{Mkt} \cdot marketPriceInUSDC_{Mkt}} \quad (40)$$

The Figure 3 will help us to understand the following three cases.

Such *healthRatio* (40), will help us to determine when liquidation is going to happen according to a critical level (below 1). We must also consider how small that *healthRatio* could be. The Figure 3 depicts three possible scenarios.

⁵"I owe you" - Document recording a debt and an informal agreement typically to pay someone

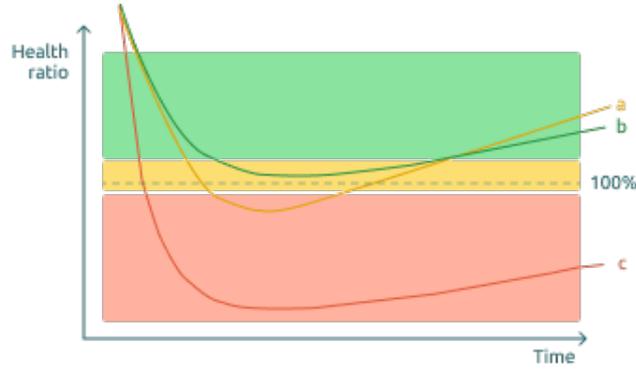


Figure 3: Liquidation case scenarios

Scenario **a)** describes the state of a loan that is not liquidated despite at a certain point it was too close to 1. In Scenario **b)** we can visualize a loan that entered into the liquidation zone, and was liquidated successfully because liquidators mitigated the exposure risk of the borrower acquiring a portion of their collateral (see section 3.5.1 for more details). Finally, at Scenario **c)** we see a case where the value of the market went down so fast that made a loan go undercollateralized equally fast, making the protocol to use the reserves to incentivize liquidators to liquidate the loan under such circumstances.

The *healthRatio* could be not that meaningful to the borrower, so the same information could be presented to them as a *healthFactor*, where the nearer to 100%, the better,

$$healthFactor = 1 - \min\left(1, \frac{1}{healthRatio}\right) \quad (41)$$

Figure 4 shows three different zones where the health factor resides, suggesting that being near to 100% is likely to be considered as a healthy loan. Being in the yellow zone is considered to start being under a moderated risk, but not that risky to be liquidated. Whereas, the red zone (i.e. being nearer to the 0%) is likely to make a loan prone to be liquidated.

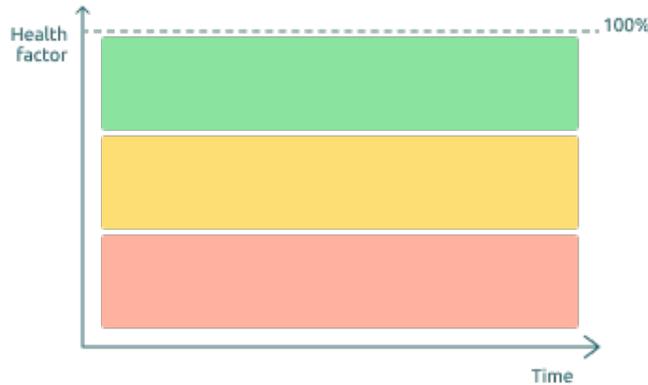


Figure 4: Health Factor

3.5.1 Liquidators

The *liquidationPenalty* is a mechanism that makes undercollateralized loans more attractive to liquidators. This incentive makes a 7% discount over the collateral, so the liquidator can get a portion of the collateral in exchange for a crypto asset used to repaid a loan and posted to the liquidity pool.

3.6 Price feeds

A Price Oracle maintains the current exchange rate of each supported asset. In addition, trusted oracles or decentralized oracles are used to obtain market prices for the cryptoassets and stable coins accepted as collateral in the Tropykus markets.

3.7 Governance

As mentioned in section 3 the protocol sponsors will act as the unique administrators over the parameters and design of the markets. This is required to test the compliance and stability as the markets are bootstrapped. At a later stage, the protocol will transition to a model of decentralized governance where the protocol will be governed by governance token holders, thus the users will have decision power and all protocol changes must be approved over the election.

4 Technology

We selected RSK as the first Tropykus platform (second layer on top of Bitcoin) to start, for several reasons

- The services that we want to offer for the people that we want to serve, demands a low cost of the fee.
- We believe in creating the financial services of the future on top of the best and most secure technology that represents the best option of hard money in the present and the future.
- It is compatible with the Ethereum Virtual Machine (EVM), which allows us to bring smart contracts on top of Bitcoin.
- RSK is secured on average by 60% of bitcoin miners. This is very important because we share the vision of the founders, promoters, projects and community of RSK.
- In Latinamerica, the most trusted and known cryptocurrency is Bitcoin.

Tropykus started on RSK testnet, to learn as much as possible with our lead users, ensure the security of their assets and understand their needs for the main net launch. When all of the security requirements are accomplished, We will launch Tropykus Protocol on Mainnet.

4.1 Smart Contracts

The protocol inherits the Compound set of Smart Contracts. Several changes have been made to the new repository available at our official GitHub repository (i.e. <https://github.com/Tropykus/protocol>). These changes include several modifications to the **kTokens.sol** file where the effects of Tropykus' Interest Rate Model happen. Also, several refactoring changes have been made to the Interest Rate Model to abstract common features and behaviours to be overridden by the Hurricane Interest Rate Model.

5 Bibliography

References

- [1] Compound: The money market protocol. Leshner, R and Hayes, G. (2019)
- [2] DeFi and the Future of Finance: Harvey C.R., Ramachandran, A. and Santoro, J. (2021)

6 Appendix

6.1 Optimal utilization rate

In the interest rate model where there is a promised base return rate (MIR) for suppliers it is important to determine the optimal utilization rate. This optimal utilization rate is a key parameter upon which the different funds receive or pay resources in order to maintain the return commitment. Mathematically, the optimal utilization rate (OUR) is determined as the intersection between the supply rates of the linear model to target the supply rate (sr^{target}) and the quadratic model for the supply rate (EI),

$$sr^{target} = EI \tag{42}$$

$$\gamma + \psi ur_{OUR} = \alpha ur_{OUR} + \beta ur_{OUR}^2 \tag{43}$$

$$0 = \beta ur_{OUR}^2 + (\alpha - \psi) ur_{OUR} - \gamma \tag{44}$$

$$ur_{OUR} = \frac{(\alpha - \psi) + \sqrt{(\alpha - \psi)^2 + 4\beta\gamma}}{2\beta} \tag{45}$$

7 Glosary of terms

- **collateralFactor**: Indicates how much a borrower can borrow according to the collateral value they collateralized.
- **baseBorrowRate**: Indicates the minimum interest rate for loans.
- **optimalUtilizationRate** (OUR): Indicates the optimal utilization rate computed by admins.
- **reserveFactor**: Indicates the slice earned by loan interest for insurance fund.
- **X₀**: Indicates the initial value for the liquidity pool token. For further information consult section 3.4.

- **blocksPerYear:** Set by an admin, tells how many blocks the protocol is expecting per year. A calculated suggestion is around 2102400 blocks per year at a rate of one block every 15 seconds.
- **liquidationPenaltyFactor:** Indicates the penalty for being liquidated that the borrower has to pay if entering into the liquidation zone. Value from 0 to 1.