Equilibrium

The first decentralized interoperable money market
www.equilibrium.io

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Authors: Alex Melikhov, Peter Sergeev / Equilibrium Lab, www.equilab.io

Abstract

This paper introduces a Substrate-based engine on the Polkadot network that lets non-custodial liquidity pools on different blockchains interact with each other. It unites them as one cross-chain decentralized lending hub with built-in synthetic assets, advanced price discovery, and bailout mechanics. The engine will be running on Equilibrium's DeFi parachain, implementing a PoS consensus mechanism with a DeFi-specific fee model. Equilibrium is designed to underlie a wide variety of decentralized finance applications.

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Equilibrium (noun): A state in which opposing forces are balanced
(Oxford English Dictionary)

1. Current challenges for DeFi

No matter the decentralized finance project, the user's journey usually starts with locking value in a smart contract. As of this writing, the total value locked in DeFi on various blockchains like Ethereum, EOS, and TRON exceeds $12.75 billion [1]. This is a tenfold increase from mid-summer 2020, but the DeFi market potential is still far from being reached.

This chapter considers the three biggest challenges for decentralized finance, which Equilibrium is working to overcome with its innovations.

1.1. Fragmentation of the DeFi space

The rise of decentralized finance has driven mass development of dApps and introduced many prominent new concepts and financial models. Some of these were inherited from traditional finance while others are a complete novelty. Among these diverse innovations, the most sustained models include pooled lending (Compound, Aave), synthetic assets (MakerDAO, Synthetix), margin trading tools (bZx, dY/dX), and exchange protocols (Bancor, Kyber).

Despite projects having some similar smart contracts, an end user's perspective on the DeFi space comprises dozens of scattered applications whose functionality often overlaps with each other. Borrowing ETH on Compound, collateralizing it on MakerDAO to generate DAI, and buying more ETH for DAI on Kyber is a process that requires the end user to interact with three different UIs and broadcast three separate blockchain transactions. Beyond that, users are forced to monitor their positions across multiple protocols. In the aggregate, this scope of maintenance is overwhelming and inefficient.

Fortunately, emerging DeFi dashboards like Zerion, InstaDApp, Argent or DeFisaver simplify the user experience by aggregating access to various dApps in a single interface. But this does not solve the problem of siloed platforms, since most of these interfaces are only compatible with the Ethereum network. The economic models attached to these dApps still exist in parallel, but they could complement each other if they were integrated.

Equilibrium proposes combining pooled crypto lending that supports a collateral basket by generating synthetic assets and a liquidity cushion for bailouts would result in a more sustainable structure and unite the fragmented DeFi space. At the same time, users will be able to access DeFi instruments that they previously used via distinct protocols all in one single place.

1.2. Missing cross-chain composability

Things get more complicated when it comes to operating across multiple blockchains. The current lack of seamless cross-chain interoperability forces users to juggle transactions among several networks and switch between separate wallets, each of which holds private keys.

The user flow gets even trickier due to standalone peg in/out services. As a result, most users and traders find it more convenient to transfer value between different blockchains using centralized exchanges. But this is an inherently insecure setup since it requires end users to trust a third party with their funds.

In any case, the bigger issue is that liquidity in existing systems is isolated and limited by the boundaries of underlying blockchain networks. Ethereum currently holds a leading position in the field, with various money market, trading, and asset exchange protocols in its ecosystem. The obvious drawback here is that non-ETH-based assets cannot be used effectively inside those protocols. Thus, a big part of the ecosystem remains underutilized while the value of the assets locked in DeFi is dwarfed by comparison to the market cap of the overall crypto space.

Cross-chain communication has thus emerged as a major challenge of decentralized finance: interoperability will bring additional liquidity and asset variety into the DeFi space — consider the recent explosive growth of the WBTC token on Ethereum/ It will also open up possibilities for building DeFi infrastructure like multi-currency lending protocols, cross-chain DEX with margin trading, derivative contracts, and liquidity pools.

Interoperability also offers huge potential for further scalability, since the initial system on Equilibrium's parachain is designed to handle all the core logic of the application. The task of connecting a new blockchain comes down to bridging it with the Polkadot ecosystem and rolling out an escrow smart contract in the network being connected.

1.3. The problem of liquidations in distressed markets

Another problem of major DeFi protocols is a suboptimal auction model for liquidating bad debt. Selling collateral at a discount can fail badly when the market starts to crash. It may turn out there are simply no market players willing to buy a rapidly depreciating asset, no matter the discount. It is important to keep in mind that the risk of an undercollateralized loan remains on the system as long as its collateral hasn't been liquidated. This can result in losses for risk-averse users who hold collateral in the same pool, and can even lead to system shutdown. The problem is further exacerbated by rising transaction fees on the blockchain when the network becomes congested. In order to transact quickly, you have to pay exorbitant fees.

Recent experience shows us that it is not only market conditions that can adversely affect the auction model. In March 2020, a clog in the Ethereum network amid a surge of transactions led to an operational glitch in MakerDAO's auction system. While most keepers who meant to participate in auctions couldn't broadcast blockchain transactions, some of them used this

incident to increase transaction costs, bid almost zero on $6,000 auctions, and win. These zero-bid auctions resulted in more than $6.5 million in losses for the MakerDAO protocol. [2]

We can avoid rash actions in chaotic situations like these by setting liquidity cushions for bailouts upfront. This can be solved by using third party agents (called “bailsmen”) who provide liquidity in advance and earn fees by securing loans.

2. Equilibrium’s cross-chain engine for liquidity pools

Equilibrium consists of a Substrate-based engine on the Polkadot network and smart contracts on bridged blockchains that act as non-custodial liquidity pools. The engine enables cross-chain interoperability for these pools and unites them into a decentralized lending platform with advanced price discovery and bailout mechanics.

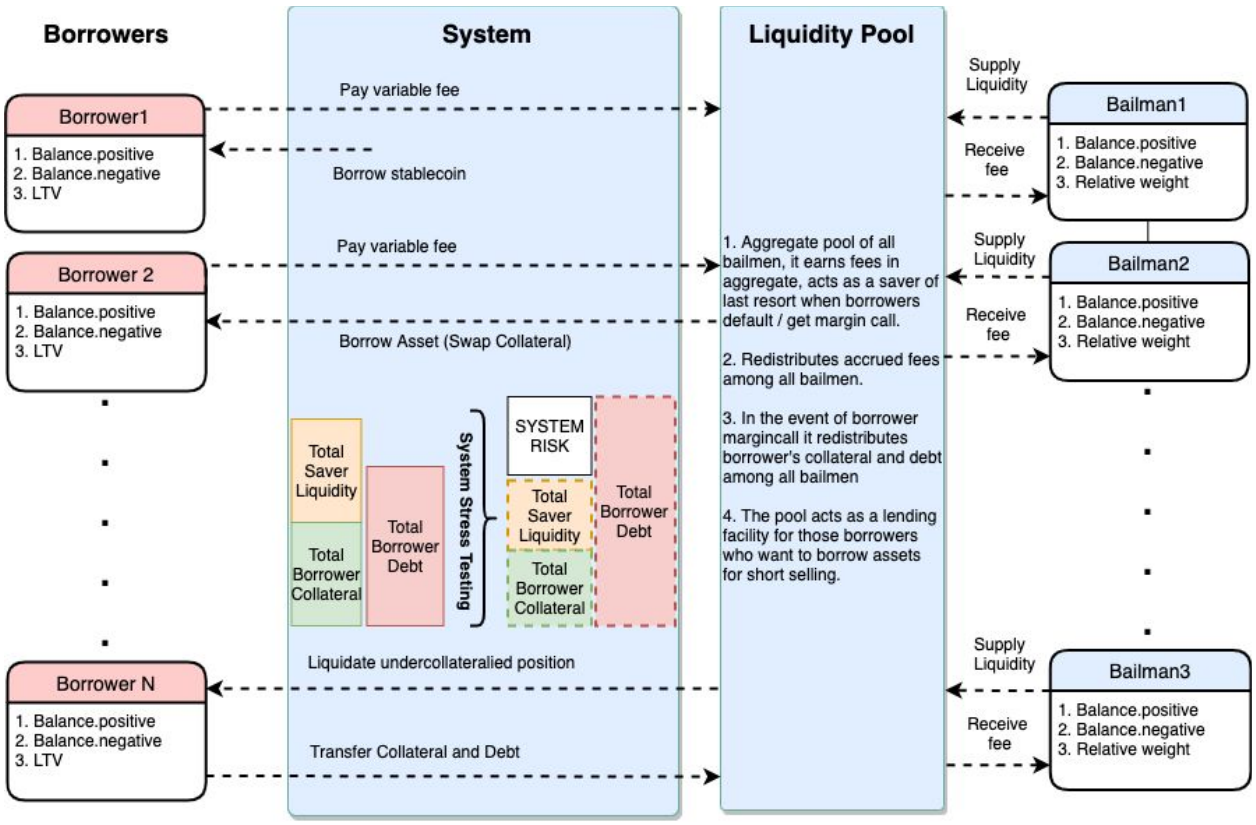
Equilibrium is addressing the three main challenges of DeFi that we outlined in the first chapter. It is eliminating DeFi fragmentation by offering a one-stop-shop to meet the demands of various DeFi users. Thanks to the technology underpinning the platform, it delivers interoperability out of the box. Its liquidation mechanism provides for bailout liquidity to be settled in advance. It thus mitigates the risk of a lack of auction participants to buy liquidated collateral after market turmoil.

2.1. The product and its features

Equilibrium has three user roles in its system — lender, bailsman, borrower, and trader.

- Lenders can stake crypto assets and earn passive income via pooled lending.
- Bailsmen can take on risk by securing loans in the system with their assets and earning additional premiums.
- Borrowers can borrow crypto and generate synthetic assets or decentralized stablecoins, all with an automatically defined APR.
- Traders can trade cross-chain

Users transact only with blockchain networks of their choice, so there is no need to match counterparties (unlike in peer-to-peer systems).



2.1.1. Staking

Lenders, bailsmen, and collateral providers, and all users who provide liquidity on PoS/ DPoS blockchains will be able to earn yield on their assets. The platform introduces a mechanism of risk-free staking, locking tokens into smart contracts that it uses as “bridges” to other blockchains. These smart contracts in turn can use stakes for generating additional rewards from the inflation-based economies common in PoS systems. Equilibrium will be distributing those rewards to its users.

One drawback here is that on the most blockchains bridge contracts should not use their entire crypto asset holdings for staking, since the effective funds lock doesn’t allow for timely cross-chain unwrapping or withdrawals. The natural decision here is to introduce a reserve requirement for occasional withdrawals so users don’t experience any delays. The size of those reserves should be sufficient to cover withdrawal demands during unsteady market conditions. The actual figure will be determined after we capture and extrapolate real data observed in practice.

2.1.2. Lending

Users can lend out a fraction of their holdings to others who would like to borrow assets for some purpose. For example, they can sell them short or fulfill their liabilities with third parties.

One primary difficulty to overcome here involves the depletion of the lendable asset and the inability of lenders to leave at their will when this happens. They must either wait for a sufficient number of borrowers to bring the asset back to the pool or for new lenders to add collateral to the pool for lending. Otherwise they can instantly unwind their position against the reserves.

This is why we have decided to separate the notion of lenders and bailsmen, at least on the interface level. Any bailsman will have the choice to become a lender by setting a corresponding flag when providing cross-chain liquidity. We will track separate aggregates on lendable assets, and will set governance-defined limits on the total value of assets that will be available for borrowing. Bailsmen who become lenders will be entitled to additional system fees that come from users borrowing assets for the purpose of funding or selling them short.

On the other hand, lenders do not bear any risk of liquidation. They transfer this risk to bailsmen and always get either the loan asset back, or the value of their lent assets in stable coins depending on the liquidity conditions of the bailsmen pool. Equilibrium builds a system of checks and balances to incentivize market participants and make sure the liquidity in any given asset isn't scarce, given current levels of borrowing.

Our pricing and risk model stays intact when users borrow a crypto asset or create a synthetic asset. We use negative token balances to reflect borrowing crypto assets beyond our stablecoin, tracking negative portfolio balances to gauge users' debt levels and system risk metrics.

2.1.3. Bailouts

Bailsmen are unified in a single liquidity pool where they share risks and losses. Such a system design is ideally suited to highly leveraged borrowing, a necessary feature for any DeFi-related ecosystem to grow. Just think of decentralized margin trading.

When borrowers default on their debt, collateral gets redistributed among bailsmen on a pro-rata basis given their relative liquidity in the pool. A bailsman can withdraw their funds from the bailout pool only after repaying a respective fraction of the accumulated debt.

2.1.4. Borrowing

Crypto assets carry a volatility risk, so when borrowers use them as collateral, it requires additional collateral and a fee. We expect borrowers to supply various crypto assets as collateral via cross-chain wrapping, and will consider their overall collateral portfolios rather than treating each collateral token separately (this is a common shortfall in DeFI behemoths like MakerDAO and Compound. Each borrower will pay a floating rate fee based on their collateralization ratio, particular portfolio, and associated volatility risk.

2.1.5. Synthetic assets and decentralized stablecoins

Equilibrium's design introduces a cross-chain store of value for the DeFi space. The following is a brief overview of the features that users will be able to enjoy with Equilibrium:

- Users will be able to generate decentralized stablecoins on the blockchain of their choice by supplying collateral (from any other blockchain of their choice). For example, a user could say that they want to mint a stablecoin on the ETH blockchain by providing collateral on the EOS blockchain, and the substrate will handle the balance sheet.
- Users will be able to generate synthetic assets of their choice (given that corresponding price feeds are available) on the blockchain of their choice or trade them in a decentralized fashion inside Equilibrium's substrate.
- The option to count one user's synthetic asset as another user's liability introduces a fractional reserve feature, letting us significantly expand or lever the supply of these synthetic assets. This is similar to the kind of fractional reserve banking that is already common among the world's major banking institutions.
- Synthetic assets can be easily exchanged without the need for an on-chain order book and matching engine. This is basically a swap of one form of asset or liability into another form of asset or liability.

2.1.6. Trading

In addition to issuing decentralized stablecoins, borrowing assets, and bailing out loans, the substrate technology lets Equilibrium build additional products on top of it. Equilibrium's asset module, as well as risk and pricing models provide out-of-the-box Decentralized Exchange functionality. DEX built on Polkadot with Equilibrium engine behind it has several advantages compared to existent DEX-es in the Ethereum ecosystem:

Different assets from different chains

Equilibrium has the capability to go beyond the limits of current Ethereum DEX's with the opportunity to add tokens from the Polkadot ecosystem as well as from other blockchains to the exchange. In doing so, the traded pairs on Equilibrium DEX will not be limited to ERC20 tokens like other DEXs, but can be any blockchain that can be connected to the Polkadot ecosystem.

High speed and low transaction fees

A lot of limitations in the field of trading come from the high cost of transactions, making scalping or small lot trading ineffective in the blockchain environment. Scalability of substrate and Polkadot technology allow Equilibrium to overcome this issue, as there's no mining and the consensus is reached much faster in Polkadot compared to, for example, Ethererum. Furthermore, designated off-chain workers and unsigned transactions make traders' life even easier, as they potentially allow for placing numerous orders without paying transaction fees, but at the risk of allowing the denial of service attack, so the exact approach has to be chosen carefully here.

High leverage

Equilibrium's approach to modeling collateralized loans allows for competitively low levels of

collateralization of user portfolios, which means that high leverage is achievable. Want to trade 20x or even 100x your capital in a fully decentralized fashion? Use Equilibrium!

2.1.7. How Equilibrium compares to other projects

Compared to the other top DeFi protocols, none can exceed the user value and system stability features offered by Equilibrium:

Feature	Equilibrium	Compound	MakerDAO	Synthetix
Cross-chain enabled	Yes (Polkadot native)	No	No	No
Fee token	Built-in decentralized stablecoin	cTokens, converted to underlying collateral	MKR	SNX
Collateral-backed	Yes	Yes	Yes	Yes
Borrow stablecoins	Yes	No	Yes	Yes
Borrow assets	Yes	Yes	No	Synthetic assets
Unified liquidity pool	Yes	No, separate money markets for each token	No, separate vaults for different kinds of collateral	Yes
On-chain risk framework and stress testing	Yes	No	No	No
Collateralization requirement	105%*	133.33%**	150%	800%***
Liquidation mechanics	Redistribution of debt and collateral among the pool.	Auctions	Auctions	Redistribution of debt and collateral among the pool.
Interest rate pricing	Closed-form pricing formula for an infinite-maturity	Arbitrary supply-demand formulas for each market.	Arbitrary stability fee set via MKR governance	N/A only system fees for trading, exchanging synthetic assets.

	collateralized loan according to the Black-Scholes model			
Price discovery	As borrowers take out loans and prices fluctuate, the system could become riskier: interest rate pricing adjusts to drive the entire system to the predefined liquidity target set by system governance.	No	No	No

* could be set lower
** minimum across all available markets (SAI, DAI, USDC, ETH)
*** the 800% figure comes from the fact that they use their utility token SNX as collateral

2.2. Governance

Governance plays a crucial role in Polkadot's ecosystem. Equilibrium's substrate will strive to support Polkadot's governance model in its entirety with the help of a democracy pallet to let EQ token holders vote on various matters pertaining to how Equilibrium functions.

2.2.1. Management of system parameters

Governance inside of Equilibrium's substrate will be managed using EQ tokens. EQ token holders use their stake to vote on system parameter changes proposed by the community. All changes require a stake-weighted majority to be agreed upon.

There are several system parameters that are subject to change via decentralized governance. The list will grow as the ecosystem develops and matures.

parameter	**description**
Minimum LTV	The absolute minimum below which no collateralized borrowing may happen. It governs the borrower's maximum risk.
Liquidity target	Shows what fraction of stressed system losses

	should be held in aggregate in the bailout pool. It governs the bankruptcy risk.
Scale bounds	Risk model volatility scaling bounds.
Fee reserve weight	Shows what fraction of borrower-generated fees go into the stability fund. It governs bankruptcy risk.
Price data parameters	Number of points and frequency to consider in statistical calculations.
Asset discounts and/or VAR confidence	Parameters used to stress-test collateral and debt portfolios for upside and downside jump risks.
Borrowing limits	Limits how much of the bailout pool will be available for borrowing assets. It governs substitution risk.
Supply caps	Defines the maximum allowable collateral asset concentration across the entire system.
EQ limits for bailsmen	Defines the minimum required and maximum allowable weights in a user's portfolio for them to become a bailsman and earn income.

2.2.2. Adding and removing collateral types

The addition of new collateral types involves analyzing asset market liquidity and supply, and relates to concentration risk. The function of including new assets as collateral and lendable assets will be delegated to system governance as well.

Equilibrium uses a top-down free float and bottom-up instant market liquidity approach to gauge the risk of concentration of a particular kind of collateral. The model then comes up with a single synthetic asset supply cap figure. The supply cap for a given asset is one of the parameters that will be set via governance mechanisms.

2.2.3. Shutdown

This scenario may unwind if all the measures for ensuring the stability of Equilibrium's decentralized stablecoin (and the entire system's creditworthiness) fail, and there are more unhandled liabilities within the hub than there are assets. The system's governance will have the ability to forcefully cease operations if it ever reaches this state. The final losses will be covered by Equilibrium's stability pool, making sure that the collateral of well-capitalized users is returned in full.

2.3. Economic model

Equilibrium's proposed economic model, which is further divided into a risk model and a pricing model, revolves around the notion of credit risk. Credit risk is the risk of a loss resulting from the fact that a borrower or counterparty fails to fulfill its obligations under the agreed terms. In other words, the borrower either cannot pay or does not want to pay. In traditional finance, credit risk is related to almost all types of financial instruments.

When modeling credit risk losses, one should take several important aspects into account:

- Defaults are relatively rare events by comparison to market losses. A lack of available data is an issue for both calibrating the models, as well as backtesting.
- Correlations between failures have material impact on the final result and shouldn't be underestimated. This is especially true for the crypto space, where different assets display high correlations to dominant market assets like BTC.
- Portfolio concentration risk should be taken into account.
- Loss distribution has fat tails and is not symmetric.

Credit risk models can be subdivided into two broad categories:

Structural models: These models assume that a default can be explained by a specific trigger point. For example, it can be caused by a decrease in asset value below some threshold (like the value of the debt). The value of assets itself is modelled as a stochastic process.

Reduced-form models: These models assume that defaults are driven by default intensity. No specific trigger event is assumed, but the default intensity (or default rate) might depend on changes in external factors. The relationships are estimated using historical data and econometric models.

The entire system design of Equilibrium's collateralized and decentralized store of value dictates that we should use the structural approach. It more closely reflects the current system architecture and does not rely on heavy backtesting or historical data, which the emergent DeFi space naturally lacks.

2.3.1. Risk model

Synthetic assets or decentralized stablecoins will maintain stable value if borrowers have either excess collateral or if the liquidity pool is sufficiently capitalized. Therefore, our smart contract models the capitalization of the liquidity pool with critical importance. Equilibrium utilizes a methodology similar to the SEC's Theoretical Intermarket Margining System (TIMS) [3], used for portfolio margin calculations by accredited US investors. This technology is underpinned by the idea that the margin should be set to the maximum loss the portfolio would incur under adverse market scenarios.

Initially, the stress model will involve parametric calculations of collateral and debt pools under different market conditions as follows:

Step	Explanation
Calculate the value of the collateral pool	Sum of dollar values of all tokens held as collateral. C = sum(Q(i)*P(i)), where Q(i) is the total balance of i-th currency in the collateral pool and P(i) is the price of i-th currency.
Calculate the value of the debt pool	Sum of dollar values of all tokens held as a debt (negative balances). D = sum(Q(i)*P(i)), where Q(i) is the total negative balance of i-th currency and P(i) is the price of i-th currency.
Calculate the value of the bailout pool	B = sum(Q(i)*P(i)) - total bailsman debt where Q(i) is the total balance of i-th currency in the bailout pool and P(i) is the price of i-th currency.
Calculate the value of the collateral pool in stressed market conditions (downside risk).	Cstressed = C * (1 - VaR(C)), where VaR(C) is a Value at Risk measure at 5 sigma by default.
Calculate the value of the debt pool in stressed market conditions (upside risk)	Dstressed = D * (1 + VaR(D)), where VaR(D) is a Value at Risk measure at 5 sigma by default.
Calculate the value of the bailout pool in stressed market conditions	Bstressed = B * (1 - VaR(B)), where VaR(B) is a Value at Risk measure at 10 sigma by default.
Calculate insufficient collateral	Cins = max(0, Dstressed - Cstressed)
Calculate scale factor	Sf = max(min(Cins / Bstressed)^rho, upperLimit), lowerLimit) - bounded in [lowerLimit, upperLimit] range scale factor .rho is a sensitivity parameter.

When performing statistical tests such as Value at Risk, the following complications naturally arise: given the sample distribution of returns available to us, what is the best distribution fit of the left tail, and how do we account for sample bias? A sample of discrete interval collateral returns is only one sample drawn from the actual law that governs collateral return, so how do we account for parameter uncertainty?

Equilibrium's roadmap entails more complicated, non-parametric methods for portfolio stress-testing to answer these questions. One of the approaches we will consider is a decomposition of portfolio risk to model the dependence structure among the assets, and to see if the risk contributions of various portfolio components are significantly different. We will use the research outlined in endnote 3 for these purposes.

2.3.1.1. Liquidation mechanics

Borrower losses are distributed across the entire bailout pool. If the value of a collateral portfolio falls below the value of a debt portfolio for a given borrower, then it triggers liquidation. A borrower's collateral and debt are redistributed among bailsmen across the entire pool, and every bailman is given his share of collateral and debt based on his relative share of the entire bailout pool.

We will use relative portfolio weights initially. For example, a bailsman with 10% of the entire bailout portfolio weight will receive a 10% share of user collateral and user debt respectively. At later product stages, we will migrate to more robust measures like risk weighting.

Furthermore, if the entire bailout pool becomes insolvent (the value of liabilities exceeds the value of assets), the stability fund comes into play and processes unhandled liabilities from its holdings.

If we take a look at the Lending pool at times of liquidation, lenders either get their assets back (if there is enough bailsman liquidity to cover for the shortfall) or USD stable coins (if there is no bailsman liquidity to cover for the lender's shortfall).

2.3.1.2. Stability Fund

In the final instance, the Stability Fund will guard system solvency. This is the system's fourth line of defense after overcollateralization, bailouts, and auction liquidations. It's a kind of "insurance policy" that guarantees Equilibrium's system recapitalization in case extraordinary market events drain the system's bailout pools and prevent auctioning.

At first, Equilibrium will use its own capital to establish the Stability Fund, just as we have already done on the EOS blockchain, where we have allocated more than $12 million in reserves (learn more here). After that, the fund will continually be replenished by part of the fees generated from borrower activity.

2.3.2. Pricing model

The pricing framework is an integral part of the cross-chain collateralized lending and borrowing system. The pricing problem confronts borrowers and lenders alike. There's great research on this by the team of Xia and Zhou (2007) [5]. They derived a closed-form pricing formula for an infinite-maturity stock loan by solving the related optimal stopping problem according to the Black-Scholes model.

The model takes the risk-free interest rate, the loan rate, collateral volatility, potential dividend payments, and the initial debt as its parameters. It is only relevant if the fee rate is higher than a risk-free interest rate. It leads to an elegant solution for the interest rate offered to borrowers based on the position collateralization ratio and collateral portfolio volatility.

As collateral price and volatility change over time, the borrowers' interest rate is adjusted using the pricing model — borrowers pay a floating premium rate. Premium adjustment is inversely proportional to collateralization levels and directly proportional to the level of collateral portfolio volatility.

The interest borrowers pay is constantly accumulated on a designated system account from which redistribution to bailsmen and lenders happens. There is a fraction which goes to Lenders and a fraction which goes to Bailsmen. Overall, lenders are subject to lower interest rates since they do not bear any risks inside the system. This parameter may dynamically adjust based on current relative liquidity conditions inside bailsmen and lender pools in any given asset: e.g. it makes sense to incentivize users (increase a rate attributable to bailsmen) to bring more liquidity into the bailsman pool if there is not enough of borrowed asset there to cover for the possible liquidations.

Once we start accounting for the critical LTV level with continuous monitoring, then the structure changes and the Xia-Zhou model does not apply. In reality, the barrier monitoring is discrete (on-chain rate update intervals), and the collateral does not behave like a gaussian. It would be best to model the collateral price dynamics with a jump diffusion process.

Adding margin calls and liquidation turns the American option into an down-and-out American barrier option. The penalty for not posting collateral when the price drops below the critical LTV would be included in our adaptation of the Ekstrom model [6].

Equilibrium will further consider pricing with jump risk and build on the hyper-exponential jump diffusion (HEM). We may also consider the double exponential jump diffusion model (DEM) [7] and/or the jump-to-default extended constant elasticity variance model (JDCEV) [8]. Pricing models will consider infinite horizon loans similarly to the initial model.

2.3.3. System Fees

Borrowers pay system fees when taking on liabilities, whether it's generating decentralized stablecoins, creating or borrowing synthetic assets, or borrowing other crypto assets for funding or trading purposes. These fees are variable and depend on individual borrower portfolio constituents, volatility, and collateralization as described in a previous section.

The constant coefficient R0 in the system fees equation is a parameter that will be set by system governance. It will be attributable to the Equilibrium foundation as a main source of final reserves in case of bailsmen insolvency. This fee will be collected in EQ tokens.

System fees will be redistributed among validators and bailsmen. The proportion of the system fees each group gets is a dynamic coefficient that will largely depend on the amount of debt in the entire system in relation to average daily transaction volumes.

If transaction volumes are low, for example, validators will get an increased fraction of system fees to cover possible shortfalls. On the other hand, if transaction volumes are high relative to total system debt levels, validators will get an ever-diminishing fraction of system fees. The balance point being the initial ratio of total debt to average daily transaction volume (the fee ratio) in turn depends on the actual transaction fee we set, as well as the average borrowing rate payable by borrowers and the share of system fees attributable to validators.

The “indifference target” is the fee ratio where validators make no economic distinction between earning transaction fees and system fees. To drive the fee ratio there, we will dynamically adjust the validator share of system fees based on the median fee ratio calculated for the past 24 hours.

3. Equilibrium’s DeFi parachain

Equilibrium will build its chain as a standalone blockchain using substrate technology, and when Polkadot goes live with version 2.0, it will become a parachain on Polkadot and enable interoperability for Polkadot’s ecosystem participants and assets. This provides valuable infrastructure to the broader Polkadot audience for building dApps.

3.1. Polkadot substrate

The substrate is a blockchain development framework with a completely generic State Transition Function (STF) and composable components for consensus, networking, and configuration.

The substrate is a core component of the Equilibrium project. Equilibrium will create its own custom DeFi blockchain using the substrate core. The primary modules will include:

Parameter	MVP	Beta
Consensus type	PoA	NPoS
Initial number of validators	5	20
Target number of validators	20	20
Block time	6 secs (maybe less after tests)	6 secs (maybe less after tests)

Transaction fee	Standard in EQ tokens with balance adapter	Standard in EQ tokens with balance adapter
Governance	SUDO	Decentralized governance model using EQ tokens
Contracts	Ink	Ink
Consensus mechanism	AURA	BABE
Finality	GRANDPA	GRANDPA
Timestamp	Standard (needed for oracle and fee)	Standard (needed for oracle and fee)

3.2. Consensus

Consensus is a method for coming to agreement over a shared state in a decentralized network. In order for the blockchain to confirm transactions and move forward, all nodes in the network must agree and come to consensus. This is how nodes in a decentralized network stay synced with each other.

During the MVP stage, Equilibrium's substrate will operate with a mechanics of PoA consensus called AURA, which is provided out-of-the-box by Polkadot. This is a relatively simple algorithm where time is divided into discrete steps of a certain length, and at each step, only one validator is allowed to produce blocks. It is improper to produce more than one block per step or to produce a block out of turn. Finality is achieved using a simple majority vote and adheres to the relation of $2f + 1 <= n$, where f is the number of faulty nodes and n is the total number of nodes. This relationship implies that faulty nodes cannot finalize blocks by themselves.

At the beta stage, Equilibrium will migrate to the BABE/GRANDPA consensus mechanics and finality algorithms. This hybrid consensus stems from the need to provide both probabilistic and provable finality, as described in Polkadot's documentation. This is a NPoS consensus (as opposed to the PoA used in our MVP) and will require EQ staking, rewarding and punishing Nominators and Validators alike with EQ tokens.

3.3. Nominators and Validators

At later product stages, Equilibrium will use Polkadot's native staking mechanics and will adhere to the notion of validators and nominators. Since the number of validators in Equilibrium's substrate will likely be limited, most of the users who will stake EQ tokens will be nominators. Nominators do not perform any critical system work or maintenance, but they too can be slashed in case the validator they nominated misbehaves.

In Proof-of-Stake (PoS) networks like Polkadot, there will be natural competition between assets being used in staking (for yields) and assets being invested in DeFi (for returns). The current inflationary model for Polkadot's projects suggests 10% yearly inflation and ~20% annual return. EQ inflation has to be much lower to balance the rate of returns from staking and using EQ in DeFi. Determining the appropriate inflationary model for EQ tokens is a work in progress for Equilibrium.

3.4. Fee model

There are two main sources of fees inside Equilibrium's substrate: transaction fees and fees that borrowers pay for borrowing. In order for Equilibrium's parachain to function smoothly, there should be an incentive high enough for validators to run the network. Equilibrium is aware that transaction fees alone will not provide this incentive, at least initially, since the parachain will grow gradually and there won't be many transactions in the beginning.

This is why we adhere to a combined fee approach. Validators will receive transaction fees and a fraction of system fees. As the parachain grows and the average number of transactions increases, validators will get an ever-diminishing share of system fees, and at some point, will be entitled only to the transaction fees.

3.4.1. Transaction fees

Polkadot has developed a very sophisticated fee model, where the actual transaction fees depend on predefined resource usage limits. Those are in turn calculated by modeling the blockchain's behaviour with simulations for every transaction type. There are also fast and slow adjusting mechanisms, depending on the network's throughput and block saturation levels. Equilibrium will adhere to this model and will perform all necessary tests and measurements to set correct transaction fee weights.

Using the pricing and risk models outlined in this document, we can gauge the expected fee amounts given transaction volume, debt levels, and some assumptions on collateral volatility and the overall system LTV ratio. The following chart, in which we assume 5 validators in the

system, should give the reader an idea of this :

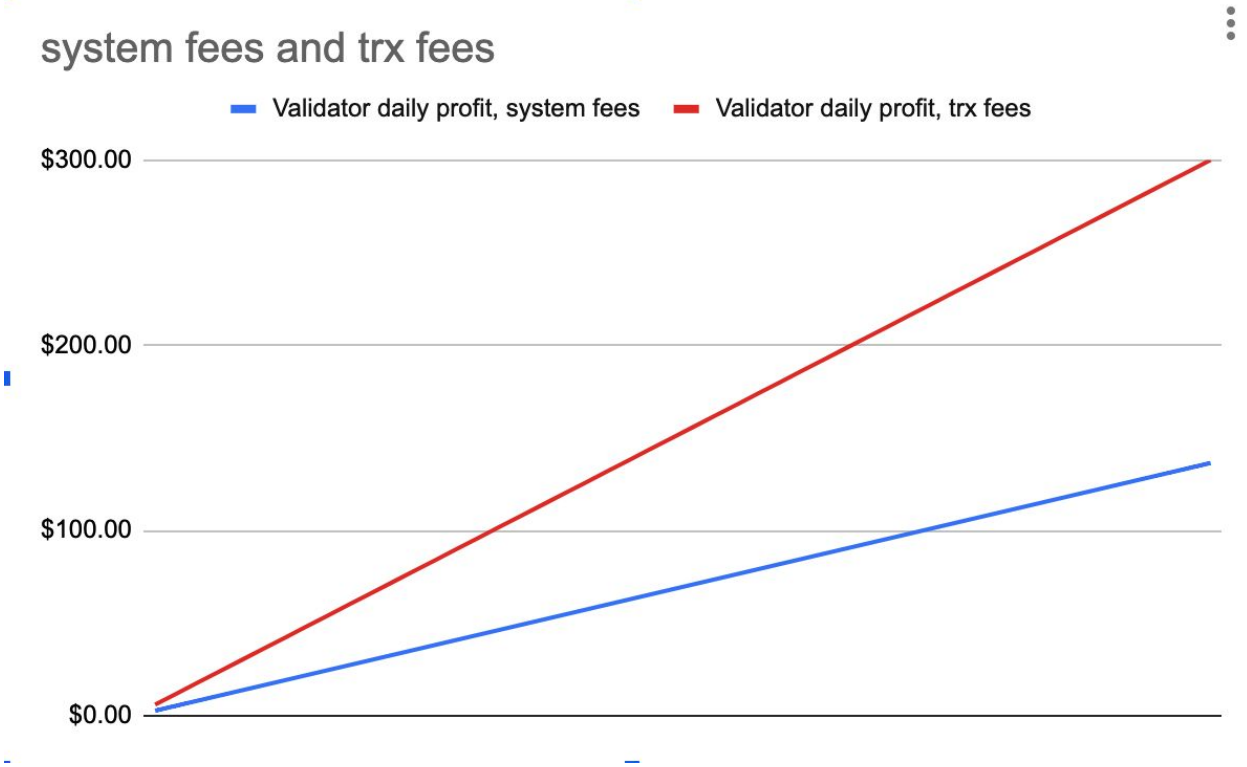


Fig.1 Validators get 20% of system fees under 2.5% average rate assumption where total system debt varies from 1 million to 50 million. Validators get 0.1% of transaction volume fees where volume varies from 100,000 to 5 million transactions a day.

We are aware of the fact that these assumptions may be unrealistic, especially given the transaction volumes and debt levels considered, but they give you an idea of the fact that transaction fees outpace system fees when the trading volume grows. To match the slopes of the two lines on the chart above, validators would need to get as much as 40-50% of the system fees, which is unreasonably high given that we want to attract bailsmen with appealing returns on their stake. As mentioned earlier, there will be an adjustment mechanism in place to make sure that validators earn a competitive reward for maintaining the blockchain's integrity.

4. Tokenomics

The EQ token is the core utility asset of Equilibrium, widely used within products built on top of it. EQs grants access to many of these products' features and governance powers. The token is used for paying fees, accessing liquidated cryptocurrency collateral, voting for block producers, and managing the framework.

In Equilibrium's DeFi parachain, the EQ token will retain all of its utility and will also be used as described below.:

4.1. Participation in bail liquidity and collateral provision

The system will be accepting EQ tokens in its bailout pool and as collateral. This will be the major use case for EQ (similar to SNX in Synthetix).

In order for any willing party to start earning system fees, they will need to post some liquidity to the bailout pool to safeguard the system and. they can lock EQ tokens as well. The requirement to participate in this pool will be set as a minimum deposit in USD.

Borrowers need to provide collateral to get a loan. Alongside with major cryptocurrencies, the system will enable settling EQ tokens as collateral.

4.2. Transaction fees

Substrate resources like storage and computation are limited, and transaction fees prevent individual users from consuming too many resources. Equilibrium uses Polkadot's weight-based fee model, where fees are charged prior to transaction execution. Once the fee is paid, nodes will execute the transaction.

Fees are paid in EQ tokens, and users may not go negative on their EQ balances for paying fees. If an account has an insufficient EQ balance, the system will trade part of the borrower's collateral into EQ tokens, and the treasury will cover the fees.

4.3. EQ staking

In order for the platform to function and allow for valid transactions to be carried out across different products, Equilibrium will rely on EQ token holders to play active roles. Participants stake EQ to perform these functions.

Staking EQ tokens disincentivizes malicious participants who are punished by the network by getting their EQ tokens slashed. The EQ required to participate in the network will vary depending on the activity being performed, the duration the EQ will be staked for, and the total amount of EQ staked.

Staking EQ tokens will play another important role within the system: stakers will have the ability to decide where the PoS consensus-based assets in their native blockchains should be staked for earning additional rewards on that staking. This is done by a simple majority vote and will require a threshold of participation to come into effect.

4.4. Governance

One other important function of EQ is that it grants access to the governance of the platform. Functions covered within governance include determining the amount and weights of fee distributions as well as upgrades and fixes to Equilibrium's parachain.

Equilibrium will use Polkadot's native approach to system governance by proposing changes and voting on them. This comes with a voting timetable, tallying, adaptive quorum biasing, and voluntary locking mechanisms in place.

5. Technical implementation

Polkadot has developed a substrate technology to facilitate easy creation of custom blockchains. This substrate comes with everything you need to create your own blockchain. The substrate's pallets make it easy to create custom blockchain-specific logic. Here are some of the benefits of using a substrate technology, which are also the reasons why Equilibrium is building one of its own:

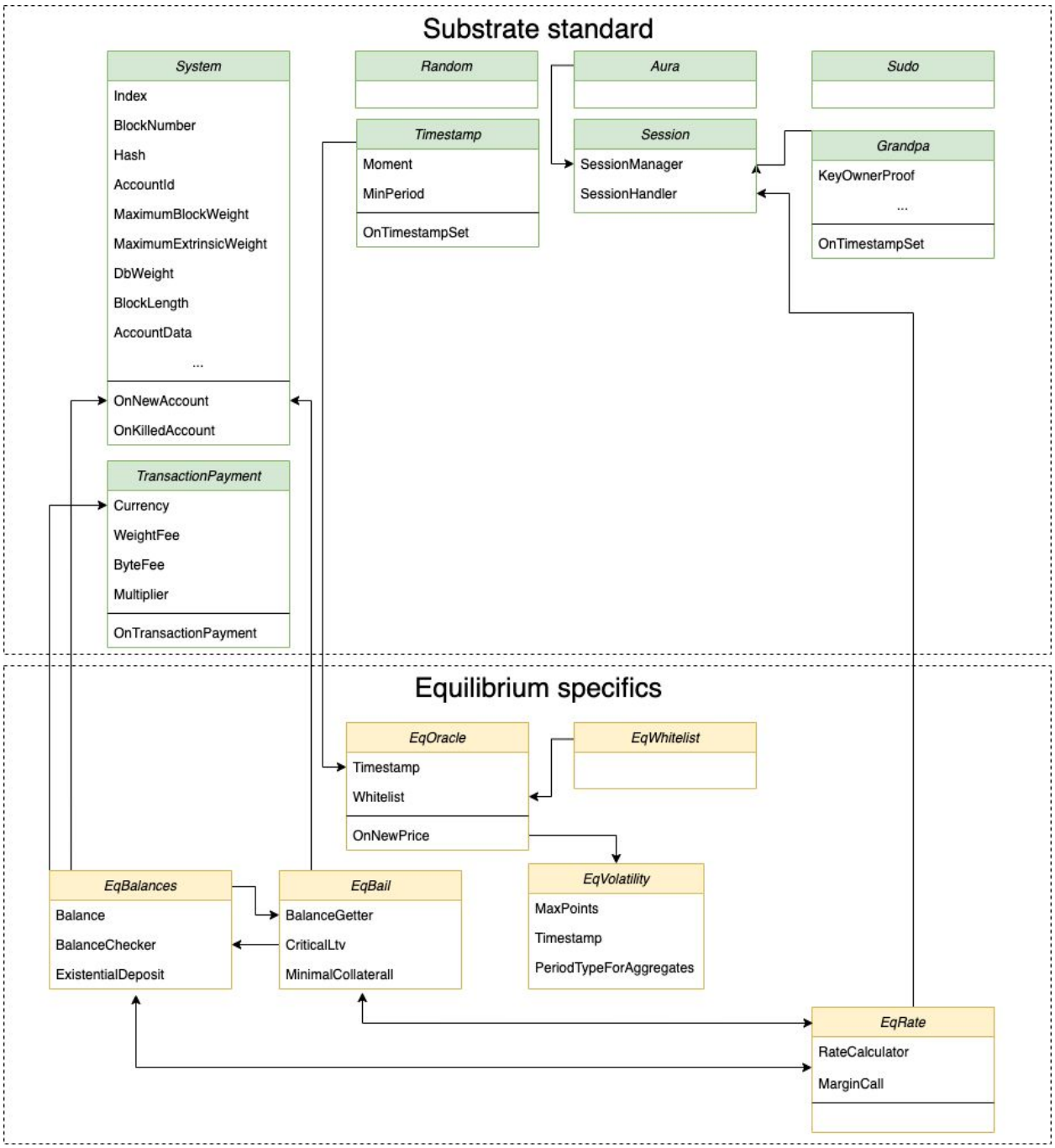
Forkless upgrades: out-of-the-box mechanisms perform easy upgrades of blockchain logic. The substrate comes with tools to help networks decide which upgrades to implement.

Consensus and finality: built-in consensus and finality mechanisms let blockchains come to a quick consensus to reach irreversibility or finality in a timely fashion.

Fast integration: Off-chain workers can integrate data, business logic, and complex computations into the blockchain with ease.

5.1. System architecture

Equilibrium uses substrate pallets as different modules for handling system components. The following is a high-level overview of what the Equilibrium substrate has under the hood:



Pallet	Description
System	The System module provides low-level access to core types and cross-cutting utilities. It acts as the base layer for other pallets to interact with substrate framework components.
Random	A simple randomizer that supports basic

	substrate functionality.
TimeStamp	Lets validators set and validate timestamps on each block. Provides functionality to get and set on-chain time.
Aura	PoA consensus pallet
Grandpa	GRANDPA finality module for runtime. It manages the GRANDPA authority set ready for the native code. Will be used in conjunction with AURA.
Session	The Session module lets validators manage their session keys,it provides a function for changing the session length, and it handles session rotation. It's used to make validators perform extra work like margin call calculations.
SUDO	Adds root users to the substrate, enables the creation of settings and later managing them under root.
TransactionPayment	Handles transaction fees and fee logic. A detailed description of fees follows below.
EqOracle	Pallet for feeding prices on-chain. Handles several data sources and feeders, and calculates the median value of an asset price.
EqVolatility	Calculates per-token volatilities and asset correlation matrices with a given frequency (default time interval = 1 day)
EqWhitelist	Allows root to manage the whitelist of users and validators. Whitelisted actors are allowed to feed prices into the substrate.
EqBalances	Implements Currency Trait. This pallet handles the balance operations logic for borrowers. Borrowing increases the negative balance of the asset on the account.
EqBail	This pallet handles the balance operations for bailsmen. It also contains the logic for system fee redistribution, liquidated collateral redistribution, and debt redistribution among bailsmen.

EqRates	Handles the redistribution of user subsets among the validator set with help from the Sessions pallet. Performs the following calculations: Per-borrower system fees calculations. Stress-testing of the system's collateral and bailout pools. Per-borrower LTV ratio monitoring and liquidations (margin calls).

One important concept that runs throughout the system is that the fee each borrower should pay needs to be periodically recalculated and applied. Individual borrowers trigger these recalculations every time they deposit, withdraw, or transfer assets. Validators themselves trigger these calculations as well: each time a validator gets a random list of borrowers, they will be entitled to calculate fees for that list. Validators do not pay transaction fees, so it is natural to make them perform heavy calculations like determining fees per user on a block-by-block basis.

The system design also supports auto-liquidation of undercollateralized borrowers. An off-chain worker feeds the lowest N LTV ratios by account id into the run-time. If it turns out that any of the LTV ratios breach the liquidation threshold, then the borrower's collateral and corresponding debt gets redistributed among the bailout pool stakers.

5.2. Cross-chain communications

In case there are no functional bridges in the Polkadot ecosystem when Equilibrium launches its DeFi substrate, we will build our own solution by adhering to the roadmap described further below. The technology will also enable the prompt rollout of bridges to blockchains that aren't yet connected to the Polkadot network.

Ethereum and EOS are the two biggest smart contract enabled blockchains to date, both by market cap and number of daily users. Equilibrium's cross-chain communications protocol will operate on both of these networks, and will achieve interoperability between them via Polkadot's substrate technology. Equilibrium will initially focus on bridging ETH and EOS into Polkadot, and will build DeFi infrastructure around pegged tokens coming from these two chains. As ecosystem development and growth progresses, Equilibrium will add other blockchains.

The table below outlines the roadmap that Equilibrium will adopt in building its cross-chain solution. The entire protocol will be an event-based setup where events will originate in the source blockchain and will be relayed to a destination blockchain, depending on the particular business case.

Stage	Approx. timeline	Description
Stage 1: MVP	Q1 2021	ETH relays that stake ETH and process deposit/withdrawal transactions in ETH-substrate interoperability. EOS relays that stake EOS and process deposits/withdrawal transactions in EOS-substrate interoperability. Final centralized SUDO validation of relay actions in both originating and destination chains. Substrate with relay governance and reward/punishment logic.
Stage 2: Intermediate	Q2 2021	Introduces a contestation period and another type of validator (called “fishermen”) into the setup to remove the centralized validation step. Any willing party can stake collateral to the smart contract in the blockchain where the event originated and initiate a contesting period to dispute the event when in doubt. If a fisherman wins the contest, he is entitled to a premium (the fisherman’s win will be checked in a centralized SUDO manner). If he loses, he is punished by paying a fraction of his stake.
Stage 3: Decentralization	Q3 2021	Anybody willing to become a relay stakes ETH or EOS to the corresponding smart contract and feeds events with proofs to the substrate. Any relay may contest the validity of the proof of the other relay, to either be rewarded or punished for this contest. At this point there is no need for validators to hold stakes on corresponding smart contracts. Collateral will be locked only for the period of transaction validation and finalization. ETH: to verify agreement in PoW blockchains, a *Proof of Proof of Work* is used, also called a simple payment verification (SPV).

		EOS: to verify agreement in PoS blockchains, a dynamic collection of the signatures that capture the current stake distribution of the block producers is provided. Verifying all block headers results in a proof complexity linear to the size of the blockchain. But there are techniques for achieving sub-linear complexity (logarithmic to the size of the chain), which rely on probabilistic verification. We will consider ongoing work in this direction to eventually choose a secure and economically viable approach.
Stage 4: Governance	Q4 2021	New smart contract versions both in ETH, EOS, and Substrate blockchains. Governance and parameter changes within the substrate become decentralized rather than SUDO. PoS is used where validators in the substrate stake Equilibrium's Native Utility Token to govern the entire system.

5.3. Price feeds

Any willing whitelisted party and system validators can feed prices into the system via an off-chain worker designated for this purpose. The price feeding logic consists of two main functional elements:

Medianizer:

The medianizer provides Equilibrium's trusted reference prices for different assets. It maintains the whitelist of price feed accounts that are allowed to post price updates, and a record of recent prices supplied by each address. Every time a new price update is received, the median of all feed prices is recalculated and the medianized value is updated if necessary.

Data Processor:

In order for Equilibrium's framework to function smoothly, we need to pre-process and store asset prices, as well as calculate asset stats like log returns, volatilities, and correlations to be further used in our risk and pricing modules. Any asset within the system will be handled as a double map <assetId, frequency> → (prices, logReturns, correlations, volatility) where frequency denotes the time interval between data points stored inside the prices and logReturns arrays (e.g. 1 minute, 1 hour, 4 hours, e.t.c). Those arrays will be used to calculate correlations and volatility.

6. Summary

Equilibrium has already delivered one of the most complex and useful dAPPs built on the EOS blockchain to date. But the potential for serving the greater crypto community is still largely untapped: they need a broad pool of financial products like decentralized leverage, a stable unit of account, money market protocols, and synthetic assets.

Equilibrium will become the first DeFi one-stop-shop by offering exceptional services to the users of major crypto assets like BTC, ETH, XRP, EOS, and beyond. All this will become possible thanks to Polkadot's technology and its substrate framework for creating decentralized systems. Building such a system on the substrate will in turn help Polkadot differentiate its technology from other blockchain 3.0 projects like Kava, Cardano, Algorand, and others.

The opportunity to reshape the DeFi space here is immense. The times of fragmentation of users across various DeFI protocols and different blockchains is coming to an end. Equilibrium will unite them all, and has developed a solution that combines the capabilities of the top 3 DeFi protocols by locked value (Maker DAO, Compound, and Synthetix).

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