dYdX v4: with Great Decentralization Comes Great Responsibility

Overviewing the dYdX Ecosystem's Migration from Ethereum to the Cosmos, and the Challenges that lie Ahead.

prepared by Xenophon Labs

October 2023

Disclaimer

The authors do not own `DYDX` token, nor are they affiliated with dYdX Trading Inc. or any of its affiliates. This research was funded by a grant from the dYdX Grants Program. Any opinions and results stated here are those of the authors, not of dYdX or its affiliates. Henceforth any mention of "dYdX" is in reference to the dYdX Protocol, unless explicitly stated otherwise. Nothing in this paper should be construed as financial advice or trading advice.

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Table of Contents

Part 1: Recapping dYdX's Migration from Ethereum to Cosmos

Part 2: The Challenges that Lie Ahead

Appendix

1

Executive Summary

dYdX v4 marks dYdX's transition to a fully decentralized exchange, owned and operated by the dYdX community as a standalone Cosmos blockchain. The dYdX Chain, as its called, features various improvements with respect to decentralization, scalability, and customizability. With its decentralized, off-chain order book and matching engine, dYdX Chain will enable significantly higher transaction throughput without the need for oversight from a centralized 3rd party. Furthermore, being its own Cosmos blockchain, dYdX Chain also empowers the dYdX community to customize several key properties of the protocol. This includes punishing, and perhaps even preventing the extraction of MEV (that is, Maximal Extractable Value), and ensuring dYdX Chain traders continue to pay trading fees, but not gas fees, as they do on dYdX v3.

dYdX v4 has been in the works for well over a year, with a planned mainnet launch in Q4 of 2023. In anticipation of this launch, the authors have written this report in hopes of familiarizing the reader with the unique challenges that dYdX governance has faced in migrating from Ethereum to Cosmos, how it has overcome those challenges, and how it might tackle the challenges that lie ahead. This report is split into two parts.

Part 1: Recapping dYdX's Migration from Ethereum to Cosmos

We begin with a brief overview of dYdX v4, followed by a chronology of the various steps taken by the dYdX Community to migrate the dYdX ecosystem from Ethereum to Cosmos. This includes:

- Adopting the dYdX v4 open-source software developed by dYdX Trading as the next version of the dYdX protocol.
- Establishing DYDX as the L1 token for dYdX Chain.
- Winding down dYdX v3 ecosystem incentives.
- Bridging community resources to dYdX Chain.
- Deploying novel incentives programs to accelerate the adoption of dYdX v4.

As of early October 2023, some of these are still a work in progress.

Part 2: The Challenges that Lie Ahead

Next, this report overviews the many critical components of dYdX v4 which the community will be largely responsible for researching, developing, and maintaining. This includes:

- Monitoring MEV activity and slashing misbehaving validators.
- Managing trading fee tiers and rebates.
- Monitoring and adjusting the Trading Rewards program.
- Listing new markets via permissioned or permissionless listings.
- Managing market risk parameters and monitoring missed liquidations.
- Implementing novel incentives programs targeting key behaviors across the dYdX Chain ecosystem.
- Managing governance proposals, subDAOs, and other governance parameters.

This report also includes suggestions from Xenophon Labs and other community members on how the dYdX Community might tackle some of the challenges pertaining to dYdX v4. Many of these suggestions have been posted on the community's forum, and we will be referencing them throughout the report.

A Note to the Reader

This is a living document with versions documented in the changelog. It lives in this github repository; contributors are welcome and encouraged.

This report documents dYdX's migration from v3 to v4, and the role of the dYdX Community in operating dYdX Chain. It is for informational purposes only. Thank you for reading.

Part 1

Recapping dYdX's Migration from Ethereum to Cosmos

2

Overviewing dYdX Chain

The dYdX ecosystem is migrating to dYdX Chain with the launch of dYdX v4. dYdX Chain is a Cosmos blockchain built on the Cosmos SDK using the CometBFT consensus protocol. The chain's validators will operate its order book and matching engine, gossiping orders between each other and including transactions in new blocks when two orders are matched. With dYdX v4, all components of the dYdX protocol stack are decentralized, including the front end, indexers, order book, matching engine, and governance. Before diving into the ecosystem's migration, and the future responsibilities of the dYdX community, we first provide a brief overview of some components of dYdX Chain. Those knowledgeable about dYdX Chain might choose to skip to Section 3: The dYdX Chain Migration.

dYdX v3 was an Ethereum L2 derivatives exchange built using the StarkEX engine. dYdX Trading, the team behind the dYdX protocol, maintained the exchange's order book and matching engine off-chain, with the StarkEX engine submitting transactions on-chain when orders were matched. This made dYdX v3 a hybrid between a centralized and decentralized exchange. It was decentralized in the sense that users custody their own assets, but it was centralized in that a trusted 3rd party intermediated all transactions.

With the advent of dYdX v4, the entire protocol will be operated in a decentralized fashion, with responsibilities shared across dYdX governance, the chain's validators, front end operators, and indexer operators. For a primer on dYdX v4, read this announcement from dYdX Trading!

> “Most people don't remember this, but dYdX was the #1 DEX by volume in early 2020 by a lot. At times we were approaching 50% market share. We were doing $10m trade volume / day at the time.”
>
> — The History of dYdX (so far), by Antonio Juliano, CEO dYdX

2.1 First, What is dYdX?

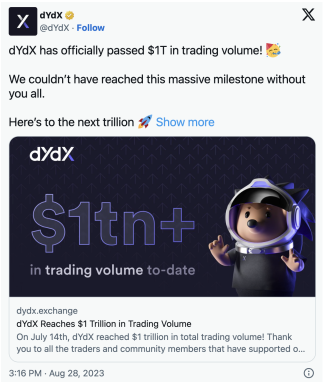
dYdX is a decentralized financial (DeFi) protocol purpose-built for trading perpetual futures contracts for major cryptocurrencies, including BTC, ETH, SOL, and many more. dYdX allows users to interact with advanced financial instruments without the need for traditional intermediaries, thus providing more transparent and efficient financial system.

With v3, dYdX emerged as one of the most successful DeFi platforms in the industry, driving billions of dollars in trading volume on a daily basis. Despite its significant success over the last few years, dYdX v3 will be deprecated in favor of the new and improved dYdX v4.

We briefly overview the various features that differentiate dYdX v4 from it's previous Ethereum L2 implementation, and from other decentralized derivatives exchanges. Following this background information, we dive into the ecosystem's migration in the next section.

2.2 Off-Chain Order Book and Matching Engine

A major benefit of developing a Cosmos blockchain, and a key innovation of dYdX v4, is that dYdX Chain's validators will operate an off-chain, in-memory order book and accompanying matching engine. An order book is a data structure that contains every user's intent to buy or sell an asset at a particular price, whereas a matching engine is the logic that matches a willing buyer with a willing seller. On dYdX Chain, validators constantly "gossip" orders between each other to ensure they each hold a roughly consistent version of the order book (not accounting for network latency). When two orders intersect, all validators run the same logic (the matching engine) to determine that the dYdX Chain must be updated with a new transaction, which is included by the block proposer in the next block.



dYdX
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dYdX has officially passed $1T in trading volume! 🥳

We couldn't have reached this massive milestone without you all.

Here's to the next trillion 🚀 Show more

dydx.exchange
dYdX Reaches $1 Trillion in Trading Volume
On July 14th, dYdX reached $1 trillion in total trading volume! Thank you to all the traders and community members that have supported o...

3:16 PM · Aug 28, 2023

Figure 1: Tweet from @dYdX on crossing $1 Trillion dollars in trading volume.

Notice that there are two main types of data packets that the protocol must track: orders and transactions. Orders are an intent to buy or sell an asset at a specific price, and are submitted and cancelled very frequently, on the order of 1000 orders per second. Transactions, on the other hand, track the exchange of an asset from one account to another when two orders are matched, updating the blockchain's state. Transactions occur less frequently, on the order of 10 transactions per second (TPS).

Since orders occur very frequently, and don't require a modification to anyone's account balances, it is unnecessarily burdensome to commit them to the chain during the consensus process. An off-chain order book and matching engine avert this problem, enabling dYdX to significantly increase its throughput. That is, dYdX Chain will be able to support more orders and more transactions (higher TPS) than alternative L1 and L2 solutions, without having any centralized 3rd party operating the order book and matching engine. According to several announcements from dYdX, this is a key reason for building on Cosmos.

This creates a more decentralized and transparent financial system, without sacrificing scalability and product quality, with the caveat that one must still trust the chain's validators to behave honestly. More on that in section 4.5.

> "Trusting code instead of corporates has become more important in times of regulatory uncertainty and corporate failures. dYdX is lighthouse example on how transparency empowers the community to decide about the future, leading to safety, fairness, and equality. The development of a Decentralized Autonomous Organization (DAO) is a cornerstone of dYdX's vision for decentralized governance and the community renewed its support the operations DAO. Further, the transition to dYdX Chain is one more step towards democratization of access to financial opportunities."
>
> — Markus Spillman, dYdX Council Member

2.3 Cosmos Proof-of-Stake: Validators and Stakers

In Cosmos, validators are the key agents that keep a network running smoothly using the CometBFT Proof-of-Stake (PoS) consensus protocol. The active validator set is determined by a validator's staked DYDX, both self-staked and delegated from other users. If validators misbehave, part of their stake, or collateral, may be slashed and burnt[1]. Cosmos chains, including dYdX Chain, derive their economic security from the value of this collateral, and the assumption that validators are incentivized to behave honestly and not get slashed.

A validator's influence is not solely determined by their own staked tokens. A significant portion of their staking power comes from regular users, or "stakers" who delegate their tokens to a validator they trust. In return, stakers earn a share of the transaction fees generated by the network, and share the same slashing risks as the validators; if a validator acts dishonestly, both can lose part or all of their staked tokens.

In the specific case of dYdX Chain, stakers hold the majority of the staked tokens, which makes them important decision-makers in the governance process. We will be referring to voters on dYdX Chain as "stakers" throughout this report.

The governance model in Cosmos and dYdX v4 is different from earlier systems like dYdX v3. In the latter, any token holder could vote on proposals. In contrast, in Cosmos and dYdX v4, the primary voting power lies with the validators. Stakers inherit their validator's decision unless they actively choose to vote differently. Importantly, this means that token holders that don't stake their tokens on the chain cannot influence the governance process.

2.4 Gas and Trading Fees

By building on Cosmos, dYdX may also customize when and how users pay gas fees. Similar to dYdX v3, there are no gas fees to submit or cancel orders, partly because doing so does not require an update to the blockchain's state. Instead, users only pay trading fees when orders are matched and assets are exchanged. These fees accrue to the chain's validators and stakers based on the validators' commission rates, and the stakers' shares of the chain's overall stake. As of now, these trading fees are paid in the collateral asset, USDC.

Additionally, the community may eventually activate a "Community Tax" on all trading fees, which it may then leverage to fund ecosystem growth or pay service providers. At genesis, the community tax will be set to 0%. More on trading fees and the community tax in section 4.

2.5 Technical Stack Overview

Throughout this report we will refer to a few components of dYdX Chain's technical stack. This includes the software run by the Chain's validators, as well as the indexers and front ends that support the Chain. At a high-level, the Indexer system allows API users and front-ends to query the current state of the protocol, including the off-chain order book. This is what allows the front-end to display the shape and depth of the order book, and compute relevant quantities such as slippage. The front-end is a user interface that allows retail users to access the dYdX protocol without writing any code, and is available both on the web and on mobile systems such as Android and iOS. We will discuss the front end in depth on Section 7, and what incentives might be put in place to get operators to deploy a variety of front ends.

The entire technical stack for operating dYdX Chain, from its matching engine, to its front ends have been open-sourced by dYdX Trading, on their public GitHub page. For a deeper understanding of the Chain's architecture, refer to this blog post.

[1] This slashing is determined by a slashing parameter controlled by governance, and is set to 0 at Genesis.

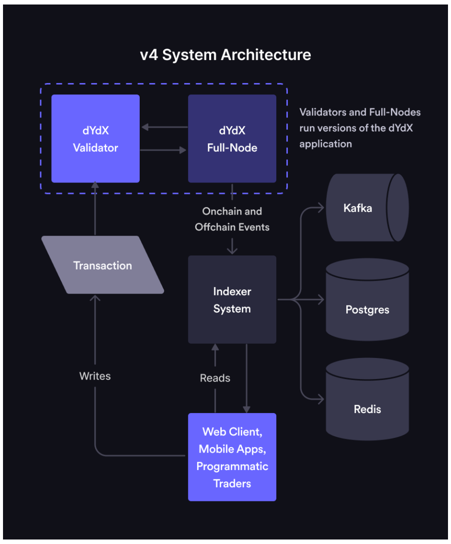

v4 System Architecture
dYdX Validator
dYdX Full-Node
Validators and Full-Nodes run versions of the dYdX application
Onchain and Offchain Events
Kafka
Transaction
Indexer System
Postgres
Writes
Reads
Redis
Web Client, Mobile Apps, Programmatic Traders

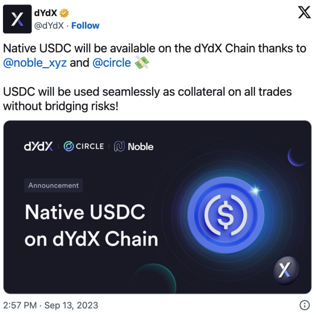
Figure 2: The v4 System architecture, taken from the v4 Technical Architecture Overview blog post.

2.6 Native USDC Collateral, Bridging, and IBC

On dYdX v3 all positions are collateralized by USDC, which is minted on Ethereum. A natural question might be, how will positions on dYdX Chain be collateralized, and will this incur some bridging risk?

Recently, dYdX, Circle, and Noble have announced that USDC will launch natively on Cosmos, powered by the Noble blockchain. This native USDC may then be used on dYdX Chain via the Inter-Blockchain Communication (IBC) protocol, which carries different and fewer security assumptions than many other L1 - L1 bridging solutions.

Aside from depositing into dYdX Chain using native USDC from Noble, dYdX users may also bridge USDC from Ethereum and its many roll-ups to dYdX Chain in one click! This is done with the support of Squid, a transaction builder built on top of the Axelar protocol.



dYdX
@dYdX · Follow

Native USDC will be available on the dYdX Chain thanks to @noble_xyz and @circle 💸

USDC will be used seamlessly as collateral on all trades without bridging risks!

2:57 PM · Sep 13, 2023

Figure 3: dYdX Announces native USDC will be used as collateral on dYdX Chain, powered by Noble.xyz.

2.7 An Aside On Cosmos

We will not go into depth on how Cosmos works in this report, and we will assume the reader has some basic knowledge of the Cosmos SDK and the Tendermint protocol. Please refer to the Cosmos SDK or Tendermint documentation if there is any confusion, or to this detailed guide to Cosmos put together by RoboMcGobo, a dYdX and Osmosis contributor.

3

The dYdX Chain Migration

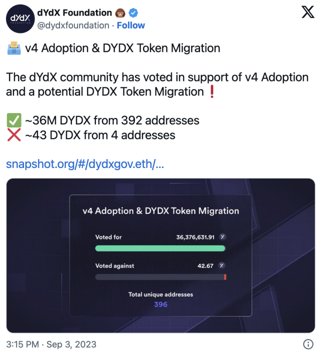
dYdX's migration from Ethereum to dYdX Chain involves several moving parts, the most crucial of which was choosing dYdX Chain's L1 staking token. In a recent governance proposal made by Wintermute governance, voters elected DYDX as the chain's L1 token, a natural choice. A key challenge then arises: bridging ethDYDX from Ethereum to dYdX Chain. In this section, we provide a chronology of this migration process. Throughout this section we will refer to Ethereum-based DYDX as ethDYDX, and dYdX Chain DYDX as DYDX.

The dYdX Foundation launched the ethDYDX token in August 2021. From inception, the ethDYDX token was owned and controlled by dYdX token holders (collectively, the "community", "governance", or the DAO). Token holders can exercise this control in several ways: they may increase or decrease the distribution of rewards, transact ethDYDX from the community's treasury, and upgrade a number of smart contracts pertaining to the ethDYDX token. Token holders vote on what actions to take through the governance process.

The migration of the dYdX ecosystem was largely a question of whether or not to migrate the ethDYDX token from Ethereum to dYdX Chain and make it the chain's staking token. On September 1st, 2023 the community voted in favor of setting DYDX as dYdX Chain's staking token, and ratified a wrapped version of ethDYDX, wethDYDX, to serve as a new governance token for dYdX v3 on Ethereum. For the remainder of this section, we discuss the steps involved with bridging ethDYDX and other community resources to dYdX Chain, as well as other actions the community has taken, or might take in the future to ensure a successful launch for dYdX v4.

3.1 Adopting the dYdX v4 Software

The first major step in migrating the dYdX ecosystem was adopting the open-source software built by dYdX Trading as the de facto next iteration of the dYdX exchange. Wintermute governance submitted a governance proposal, ratifying this adoption of the v4 software in a snapshot vote in August, 2023.



dYdX Foundation
@dydxfoundation · Follow

v4 Adoption & DYDX Token Migration

The dYdX community has voted in support of v4 Adoption and a potential DYDX Token Migration ❗

✅ ~36M DYDX from 392 addresses
❌ ~43 DYDX from 4 addresses

snapshot.org/#/dydxgov.eth/...

v4 Adoption & DYDX Token Migration

Voted for 36,376,631.91

Voted against 42.67

Total unique addresses
396

3:15 PM · Sep 3, 2023

Figure 4: Tweet from the dYdX Foundation on a successful vote to migrate the dYdX ecosystem from v3 to v4.

3.2 Setting the L1 Token

In the same governance proposal, Wintermute governance also proposed that the DYDX token should be the L1 token of dYdX Chain. In the authors' view, this was a natural choice for two main reasons: distribution and incentive alignment.

A protocol, whether on Ethereum or its own Cosmos blockchain, seeks to involve the "right people" in its governance process. dYdX v3 already boasts a successful governance structure that rests on the distribution of ethDYDX token. dYdX Chain would ideally inherit this same distribution of ethDYDX to ensure its governance process is run by individuals that are already aligned with dYdX's interests, whether they are active users of the protocol, experienced delegates, or investors. As we will discuss in the following subsection, the process of bridging Ethereum-based ethDYDX to dYdX Chain aims to retain the existing distribution of governance tokens.

We can roughly understand this incentive alignment in terms of financial stake in the success of the protocol. Ideally, a decision that harms the protocol will negatively affect the value of the governance token, whereas a good decision will increase value. This alignment fosters sound decision-making on behalf of the chain's governors (called stakers), and rests on the fact that the token's utility is tied to its decision-making and potentially interest-bearing role within the protocol's ecosystem. Recall that governance tokens on Cosmos chains are often interest-bearing because they receive rewards for being staked, such as a portion of trading fees.

An example of a token with poorly-aligned incentives might be a stablecoin, such as USDC. If USDC were chosen as the protocol's governance token, then voters would be much less aligned with the protocol's goals. A short-term decision that damages the long-term prospects of the protocol but generates some revenue stream for governance could financially benefit stakers despite damaging the protocol. The value of staked USDC would not be at risk. Perhaps a less nefarious and more probable outcome is that USDC stakers would be less likely to actually vote on promising governance proposals for the protocol! Their only financial incentive is to earn interest from staking their USDC on dYdX Chain, they have no real exposure to the protocol's success outside of that yield, and they may simply procure yield elsewhere if dYdX Chain is unsuccessful.

Conversely, with DYDX as the chain's governance token there is a much stronger guarantee that the chain's stakers are motivated to properly govern the protocol and, in theory, increase the value of their holdings. They are incentivized to make decisions with the best, long-term interest of the protocol, since that is also in their financial best interest. There is also a much stronger guarantee that existing ethDYDX holders are familiar with the protocol.

Furthermore, electing any token other than DYDX token would disenfranchise the existing dYdX community, as those token holders would be stripped away of their hard-earned governance rights.

3.3 The Ethereum to dYdX Chain Bridge

Electing Ethereum-based ethDYDX token as the L1 token for dYdX Chain entails a significant technological and logistical challenge: how will ethDYDX token be bridged from Ethereum to dYdX Chain?

> “In furtherance of its mission to support and promote the dYdX ecosystem by enabling communities, developers and decentralized governance, the dYdX Foundation has undertaken two activities in connection with a potential migration of the ethDYDX token from Ethereum to the dYdX Chain. First, it commissioned the development of an Ethereum smart contract that, if deployed, would enable a permissionless and autonomous one-way bridge for the ethDYDX token to be migrated from Ethereum to the dYdX Chain (as further described below). Second, it commissioned the development of source code that will be open-sourced such that others may use it to implement a user interface (also sometimes referred to as a “front-end”) to interact with such Ethereum Smart Contract.”
>
> — Exploring the Future of dYdX

To support the ecosystem's migration from Ethereum to dYdX, the dYdX Foundation commissioned the development of a bridge from Ethereum to dYdX Chain, which was adopted by dYdX governance in a snapshot vote. We will describe this bridge in some detail so the reader understands what, exactly, is going on when they bridge their ethDYDX from Ethereum to dYdX Chain.

Blockchain bridges essentially ensure that any bridged asset on the “detination” chain represents an equivalent claim on the original asset on the “origin” chain. A bridge connects an origin chain to a destination chain by locking up tokens in the origin chain and distributing an equivalent amount of tokens in the destination chain to some specified account. For example, a user might want to bridge ETH from Ethereum to Solana. The user sends 10 ETH to a bridge address on Ethereum, which then mints and disburses 10 “bridged” ETH on Solana to some specified account. Similarly, if a user sends 10 bridged ETH to that same bridge on Solana, they will receive 10 ETH on Ethereum. There is no actual ETH on Solana; bridged ETH is a brand new token that represents a claim on ETH on Ethereum.

By that same principle the dYdX Chain bridge will receive ethDYDX on Ethereum, and validators on dYdX Chain will mint a new token on dYdX Chain, DYDX, to a specified account on dYdX Chain. The dYdX Chain bridge is itself a smart contract on Ethereum, implemented as a new ERC-20 token called wethDYDX. When a user interacts with the contract's `bridge` function, they simultaneously lock up their ethDYDX, mint and receive an equivalent amount in wethDYDX, and finally emit an event log in the contract stating that they have locked some amount of ethDYDX token. Validators on dYdX Chain listen to these event logs by connecting to an Ethereum RPC node. Once they acknowledge this new event log, they credit the specified address on dYdX Chain with an equivalent amount of DYDX tokens. For a more detailed explanation of the bridge, refer to the dYdX Foundation's documentation.

Unlike most blockchain bridges, the bridge to dYdX Chain is a 1-way bridge. This means that once ethDYDX is sent to the bridge contract and locked, it cannot be retrieved. Instead, users receive wethDYDX, a new ERC-20 token. Although ethDYDX and wethDYDX might seem like the same token, their key difference is that ethDYDX can be bridged to dYdX Chain, wethDYDX cannot. By minting wethDYDX, the bridging contract allows bridgers to retain their governance rights on dYdX v3. Although the entire ecosystem is migrating to dYdX Chain, dYdX v3 must still be operated during the transition period, and potential governance proposals must continue to be submitted, voted on, and executed. To prevent dYdX v3 from becoming inoperable following the launch of dYdX v4, wethDYDX was introduced as a new candidate for dYdX v3 governance.

3.4 Upgrading v3 Governance

So far, all elements of the dYdX ecosystem's migration from Ethereum to Cosmos have been proposed by Wintermute governance. In the final step of their proposal, Wintermute also suggested that dYdX governance upgrades its `GovernanceStrategy` contract to account for wethDYDX when counting votes. For those unfamiliar, most governance solutions are implemented by a smart contract that tracks each voters' balance of the governance token, including any token that this user might have received or spent through delegation. dYdX v3's `GovernanceStrategy` contract was implemented as an upgradeable contract, meaning its logic can be modified to include new tokens when tallying voting power.

The on-chain vote to upgrade the `GovernanceStrategy` contract has passed and been executed as of September 2023, and dYdX v3 now has two official governance tokens. Users bridging their ethDYDX to dYdX Chain may now participate in the governance process for both dYdX v3 on Ethereum, and dYdX v4 on dYdX Chain.[2]

3.5 Winding Down v3 Ecosystem Incentives

The migration from dYdX v3 to dYdX v4 also involves migrating Rewards programs. Since the ethDYDX supply is limited, the authors argue it is best spent on growing the v4 ecosystem. Xenophon Labs proposed a gradual sunsetting of the v3 rewards programs according to the schedule on Figure 5, starting on Epoch 30. Our primary reason for taking a gradual approach is to preserve the dYdX user experience. Both Trading and LP Rewards are meaningful parts of the user experience for takers and makers on dYdX v3. Many of these users must migrate their operations to dYdX Chain, which involves varying degrees of complexity: bridging, rewriting necessary code, learning about the new API for dYdX v4, etc.. This approach gives users a buffer period within which they can gradually shift their operations from v3 to v4.

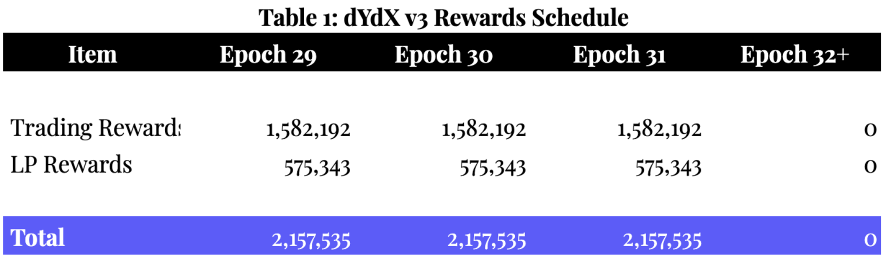


Table 1: dYdX v3 Rewards Schedule

Item	Epoch 29	Epoch 30	Epoch 31	Epoch 32+
Trading Reward	1,582,192	1,582,192	1,582,192	0
LP Rewards	575,343	575,343	575,343	0
Total	2,157,535	2,157,535	2,157,535	0

Figure 5: Proposed dYdX v3 Rewards Emissions Schedule

3.6 Bridging Community Resources

The dYdX community has control over two key financial resources, the Community treasury and the Rewards treasury. The Community Treasury is the primary financial resource the dYdX Community has to fund grants, new incentives programs, hackathons, etc.. In order for v4 governance to deploy this DYDX, it must first be bridged from Ethereum to dYdX Chain. Otherwise, the dYdX community must rely on governance proposals on dYdX v3 to deploy capital, which poses a security risk if and when dYdX v3 is wound-down. The Rewards treasury is used to fund existing incentives programs, such as the Trading Rewards and LP Rewards programs that have been central to the growth of the dYdX ecosystem for the past two years. It must, like the Community Treasury, be migrated to dYdX Chain to fund the Chain's own Trading Rewards program.

Bridging the community treasury is an incredibly delicate process involving the transaction of hundreds of millions of dollars worth of ethDYDX token. Xenophon Labs submitted a governance proposal to begin this process, outlining 3 major steps for a successful transition:

1. Wind down the v3 ecosystem incentives.
2. Bridge unvested ethDYDX tokens.
3. Bridge vested ethDYDX tokens.

We have described step (1) in the previous subsection. We now describe steps (2) and (3) of the treasury migration process.

[2] Users should not interact with the wethDYDX bridge until the bridge's User Interface is released.

3.6.1 Vested and Unvested ethDYDX

The treasury contracts both hold *vested* ethDYDX, meaning ethDYDX that is available for transactions. They do not, however, hold the *unvested* ethDYDX. Unvested ethDYDX, the vast majority of issued ethDYDX as of September 2023, sits in two vester smart contracts on Ethereum. The vesting occurs according to the schema in Fig. 6, courtesy of the dYdX Foundation's documentation.

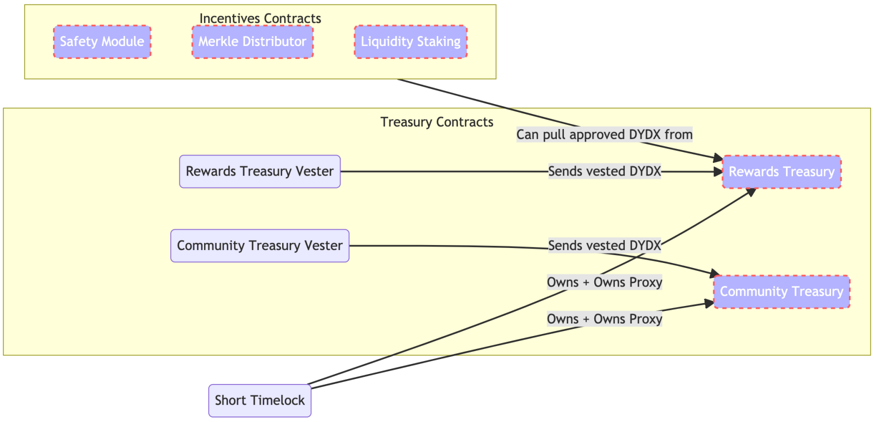


Figure 6: dYdX Treasury schema.

Vested ethDYDX can easily be bridged from Ethereum to dYdX Chain, since governance may submit transactions on behalf of each treasury. Since unvested ethDYDX is locked in the vester contracts, bridging unvested ethDYDX poses a greater challenge.

3.6.2 Upgrading the Treasury Contracts

Both treasuries are implemented as upgradeable contracts controlled by a proxy administrator contract, in turn controlled by governance. In commissioning the creation of the Ethereum to dYdX Chain bridge, the dYdX Foundation also commissioned an upgraded version of the treasury contracts, appropriately named `TreasuryBridge`. The `TreasuryBridge` smart contract extends the existing treasury contracts in three important ways: (1) it claims all unvested ethDYDX on behalf of the current vesting recipient, (2) it then changes the vesting recipient, and (3) it implements a `bridgeTreasury` function.

Suppose governance elected to change the vesting recipient of both vester contracts to a burner address, such as `0x00000`. Since the vesting recipient can only be changed by the current recipient, this would effectively burn all ethDYDX held within the vesting contracts. With all the unvested ethDYDX burnt, validators on dYdX Chain may then mint the equivalent amount of DYDX tokens on dYdX Chain, depositing them into vester contracts with identical vesting schedules. Effectively, the unvested ethDYDX has now been bridged to dYdX Chain, retaining the same vesting properties as it had on Ethereum. Crucially, this will require a successful governance proposal on dYdX Chain to credit the amount of ethDYDX burned on Ethereum to the appropriate vester accounts.

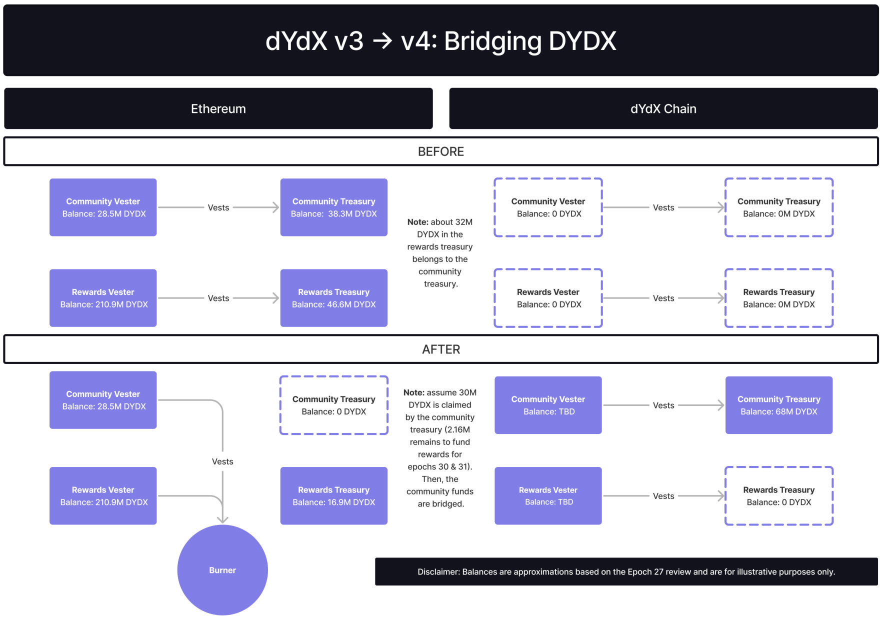
3.6.3 Bridging Vested ethDYDX

The community may choose to bridge the vested ethDYDX from the community and rewards treasuries into dYdX Chain using the `bridgeTreasury` function. The exact amount of ethDYDX to be bridged depends on the amount of ethDYDX vested at the time each contract was upgraded, and must account for the ethDYDX required to continue funding the v3 ecosystem incentives. Xenophon Labs has recently proposed that $2,157,536$ ethDYDX should be kept in the Rewards Treasury to be distributed to rewards recipients on v3 for the remaining three epochs[3]. See the schema in Fig. 7 for a before-and-after illustration of the v3 and v4 treasury contracts.

3.7 Liquidation Insurance Fund

Liquidations on dYdX v3 were performed by a liquidation engine, with the profit or loss from any given liquidation being counted against a liquidation insurance fund. Profitable liquidations increase the balance of the insurance fund, unprofitable liquidations decrease its balance.

[3] The exact amount needed to service the final epochs of rewards will likely exceed $2,157,536$ ethDYDX to account for any rewards that vest while the proposal is active.



Note: about 32M DYDX in the rewards treasury belongs to the community treasury.

Note: assume 30M DYDX is claimed by the community treasury (2.16M remains to fund rewards for epochs 30 & 31). Then, the community funds are bridged.

Disclaimer: Balances are approximations based on the Epoch 27 review and are for illustrative purposes only.

Figure 7: Before-and-after bridging the community and rewards treasuries to dYdX Chain.

The current balance of the v3 insurance fund can be seen via the dYdX v3 API here. It hovers around $20M.

On dYdX v4, a similar insurance fund exists and requires funding. Accordingly, dYdX Chain governance may choose to fund the v4 insurance fund by performing an Over-the-Counter (OTC) transaction with a market maker on Cosmos, once community funds have been bridged to Cosmos. Although this proposal has not been submitted, the community may accomplish this by negotiating an OTC transaction with a trusted counterparty. This may be done permissionlessly on dYdX chain via governance proposals, or by trusting one of dYdX's subDAOs, such as the dYdX Operations Trust, to conduct the transaction.

Once the insurance fund has been seeded with the requisite USDC, there is a stronger guarantee that the v4 liquidation engine will be able to close underwater positions despite potentially thin liquidity. For more information on liquidations and the insurance fund, see these posts from David Gogel at the dYdX Foundation: Perpetual Contract Liquidations and Contract Loss Mechanisms.

3.8 Launch Incentives

The cornerstone of DeFi user adoption has been user incentives programs. These have manifested as airdrops, liquidity mining, NFT giveaways, and other creative mechanisms for rewarding users for engaging with the protocol. To that end, a longtime contributor to the dYdX protocol, Chaos Labs, has proposed a new incentives program to bootstrap user adoption of dYdX Chain.

> “Chaos Labs proposes a 6-month Launch Incentives Program to be deployed on V4. This program is designed to motivate the seamless migration of volume and users to V4.”
> — dYdX V4 Launch Incentives Proposal by Chaos Labs

The Launch Incentives Program will be a novel kind of rewards program for dYdX. The program aims to incentivize two key behaviors on dYdX Chain: trading and deposits. To prevent sophisticated agents from being able to "game" or "farm" the program, Chaos Labs will not be disclosing the exact formula underpinning the rewards mechanism. Instead, the team will be periodically releasing the DYDX rewards earned by each account on dYdX Chain, with governance ultimately approving the disbursement of rewards through a governance vote. The more USDC you deposit on dYdX Chain, and the more you trade, the more rewards you will receive!

Up to $20M USD (in DYDX) will be devoted to the program if current and future governance proposals are successful. The program will then leverage these funds to quickly acquire new users for the dYdX protocol and, hopefully, retain them.

3.9 The Migration So Far

We have overviewed the many components involved with migrating the dYdX ecosystem to dYdX Chain. This process has involved adopting a new governance token on dYdX v3, sunsetting existing incentives programs, launching new incentives programs on dYdX Chain, seeding an insurance fund, and more. Despite the complexity of the migration process, dYdX is successfully migrating its entire ecosystem to dYdX Chain while remaining committed to DYDX token holders and a decentralized governing process.

Part 2

The Challenges that Lie Ahead

4

Validators, Trading Fees, & MEV

A primary concern for dYdX governance in maintaining dYdX Chain will be managing validator incentives. Governance controls the "fee schedule", the amount the exchange charges for processing transactions which accrues to validators and stakers. These fees are the primary financial incentive for users to validate and stake on the chain. But validators may also misbehave. This misbehavior may be nefarious: validators may censor or reorder transactions for a profit-a concept known as Maximal Extractable Value, or MEV. This misbehavior may also be a product of a genuine mistake or negligence, such as server downtime leading validators to not process enough blocks. In either case, governance must choose appropriate punishments to disincentivize undesirable behavior. In this section, we discuss what the relevant on-chain parameters are, and what additional actions governance may take, to keep validators aligned with the protocol's best interest.

On August 2023 the dYdX Foundation posted A Take on Good Practices for dYdX Chain Validators and Stakers. The post provides a guide for the dYdX community on what behaviors are acceptable or unacceptable for validators and stakers on dYdX Chain. These range from relatively obvious guidance, such as "dYdX Chain validators should not engage in MEV activities", to more nuanced recommendations regarding specific key-management systems and bare-metal setups.

Throughout this section, we will be discussing the mechanisms and parameters that v4 governance controls, and may wield to keep validators aligned with the protocol's best interests.

As we will show, making changes to these parameters and enforcing manual slashing are delicate processes that require an expert understanding of the dYdX ecosystem and its various parties. Being overly aggressive in slashing a validator might spook other validators away from dYdX Chain, whereas not being aggressive enough might encourage additional bad behavior. Therefore, it might be appropriate to form a subDAO of sophisticated community members to adjudicate or review these decisions. Such was the justification for the formation of a "Slashing Review Committee", proposed by Carl, Myles, and Derek from Reverie, a crypto investment firm that has historically contributed to the dYdX ecosystem and managed its grants program.

> “A non-exhaustive list of parameters that governance will be able to adjust includes:
>
> - Add new markets
> - Adjust parameters of a live market
> - Remove any market
> - Edit the list of 3rd party price sources that the exchange uses
> - Fee schedule
> - Trading rewards mechanics
> - x/distribution module parameters affecting trading and gas fees
> - x/staking module parameters
> - Funding rate formula
> - Control of the insurance fund
>
> ”
>
> — v4 Deep Dive: Governance

4.1 Validator Overview

We have briefly overviewed the job of a validator in Section 2. Validators are in charge of listening to orders submitted by the chain's users and gossiping those orders to other validators. One validator is selected as the current block proposer, they plug all new orders into their in-memory order book and run the chain's canonical matching engine, finally producing a block that they socialize to other validators. Once two thirds of the chain's validators (by stake weight) have signed-off on the newly proposed block, it is committed to the chain.

This process is repeated every few seconds, and requires significant resources from validators to monitor their node's performance and ensure that they are abiding by operational and security best practices. Software or hardware bugs, for instance, could create congestion on the chain, delaying or potentially censoring transactions. Validators must therefore be remunerated for ensuring the chain is operated smoothly, and they must be punished if they fail to do so, whether intentionally or unintentionally.

4.2 Positive Incentives: Trading Fees

When users submit orders to buy or sell an asset on dYdX Chain they do not pay any fees, conventionally known as "gas fees" to validators and stakers. Instead, users pay a trading fee when their order is matched with a counterparty and a transaction is executed. This fee is a percentage of the size of their order. For example, if a user submits an order to buy $100 USD worth of BTC-PERP and their trading fee is 0.1%, they will pay 10 cents in trading fees to validators if their entire order is filled. This fee is distributed roughly *pro rata* across all active validators on the chain. Each validator takes a commission on their earnings, say 10%, and then distribute the remainder to their stakers.

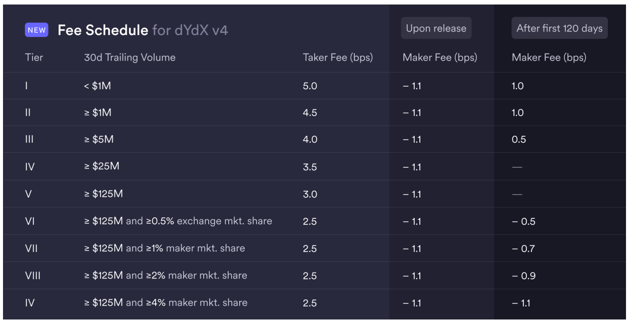
4.2.1 Genesis Parameters

The chain's initial fee schedule, along with all other of its initial parameters, are defined during the chain's *Genesis*. At a high level, the Genesis block defines the chain's initial markets, accounts, token allocations, and protocol-wide parameters. This includes many of the governance-controlled parameters that we will be discussing for the remainder of the report. Following Genesis, governance may then choose to modify these parameters, submit transactions from community-owned accounts, and add or remove perpetual markets.

Parameters are controlled by governance through `ParameterChangeProposals`. Many of these parameters are described in detail in one of dYdX Trading's latest announcements, and include the various parameters pertaining to validator incentives.

We provide an example for querying dYdX Chain's genesis state in Appendix B. We query a dYdX v4 testnet's `genesis.json` file using an RPC node provided by AllThatNode, a dYdX Chain validator. The `genesis.json` file contains all of the parameters and chain state variables discussed in this report.

4.2.2 Taker and Maker Fees, and Rebates



NEW Fee Schedule for dYdX v4

			Upon release	After first 120 days
Tier	30d Trailing Volume	Taker Fee (bps)	Maker Fee (bps)	Maker Fee (bps)
I	< $1M	5.0	– 1.1	1.0
II	≥ $1M	4.5	– 1.1	1.0
III	≥ $5M	4.0	– 1.1	0.5
IV	≥ $25M	3.5	– 1.1	—
V	≥ $125M	3.0	– 1.1	—
VI	≥ $125M and ≥0.5% exchange mkt. share	2.5	– 1.1	– 0.5
VII	≥ $125M and ≥1% maker mkt. share	2.5	– 1.1	– 0.7
VIII	≥ $125M and ≥2% maker mkt. share	2.5	– 1.1	– 0.9
IV	≥ $125M and ≥4% maker mkt. share	2.5	– 1.1	– 1.1

Figure 8: dYdX Chain fee schedule at Genesis.

The fee schedule at Genesis is depicted in Fig. 8. Notice that for both makers and takers, fees will decrease as the trader pushes more volume. This is industry-standard scheme is meant to incentivize greater trading volume and, therefore, more liquid markets. For the first 120 days following Genesis, all makers will be receiving a 1.1bp rebate on their fill size, taken from the fees paid by the taker. That is, all traders submitting limit orders instead of market orders will receive part of their notional in a rebate if their order is filled. Following the 120 day mark, the fee schedule for makers will be changed according to the schedule shown in Fig. 8. Small makers will begin paying a small fee to fill their orders, whereas large makers will continue to receive a rebate.

> “Su (2020) highlighted the asymmetric information of existing markets as takers have more information through their willingness to actively remove liquidity from the order book. In contrast, makers are subject to price risk with their idle orders, incurring 'costs of liquidity' due to this adverse election on bad fills. As a result, maker rebates appear justified for the tail risks incurred by market makers.”
>
> — Trading Fees Optimization Research by 0xCLR and 0xCchan

Of course, all of these parameters, including the 120 days cliff, may be adjusted by dYdX governance. Modifying the fee schedule is a delicate process with material consequences for price-sensitive takers and makers, and must take several factors into account. These factors may include the elasticity of takers and makers at different volume strata, the fees charged by other exchanges, and the demands of the chains stakers and validators for additional fee income.

In all likelihood, different parties might submit proposals to either raise or lower fees on dYdX Chain. Market makers, for instance, may wish to lower maker fees to make their operations more profitable and to ensure greater liquidity provision on the exchange. Validators may wish to raise taker and maker fees to ensure they can profitably operate the exchange.

A common framework for decentralized exchanges to set their fees is to follow trends on larger, centralized exchanges such as Binance. Such a comparison was posted with regards to dYdX v3's fee schedule by Wintermute governance in this dYdX Request for Comment (DRC).

Going into v4, sophisticated community members may wish to adjudicate such proposals by discussing them with both makers and takers, as well as the exchange's validators and stakers. They may compare the existing fee tiers with those of other exchanges and determine reasonable modifications, if any. Crucially, changes to such parameters may then be monitored, with these results being used as evidence in later proposals.

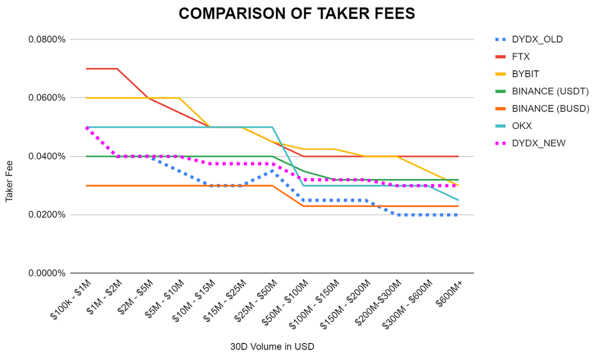


Figure 9: Comparison of Taker fees across crypto exchanges. Source.

The interested reader may refer to:

- This research paper published by dYdX community members 0xCLR and 0xCchan on optimizing dYdX's trading fees.
- This proposal from Xenophon Labs to transition away from LP rewards and towards market maker rebates.
- This proposal from Wintermute governance to introduce market maker rebates.
- This proposal from Wintermute governance to adjust maker and taker fee schedules.

4.3 Rebates or Rewards?

dYdX v4 will be entirely replacing the LP rewards program, introduced by the dYdX Foundation in dYdX v3, with a market maker rebate program[4]. As noted in a number of governance proposals, market maker rebates are likely a better incentive for top-of-book liquidity, and provide a more sustainable incentive for liquidity provision. That is, they don't require further inflation to the DYDX token.

We invited @0xCchan, a dYdX community member, to offer further insights on the differences between LP rewards and rebates:

> The LP Incentive Programme was implemented to encourage MMs to continuously provide two-sided liquidity to markets through rewards. A previous review on the state of the orderbook was done in May 2023, alongside suggested schemes and mechanisms proposed. With the decentralisation of the orderbook, Xenophon Labs has highlighted that the 'true state' of it will not be clear and hence different metrics such as depth, spread and uptime will be more challenging to monitor. Therefore, we would need to rely less on orderbook-driven data and shift to clearly defined metrics.
>
> The most straightforward mechanism would be a rebates solution, where LPs are proportionately rewarded based on the volume churned. This can be easily computed based on on-chain transaction data, where necessary.
>
> We may compare a rebates mechanism against the previous LP rewards scheme (prior to the 50% reduction) by looking at the dollar value of either incentive, shown in Table 1.

	Volume (Rounded Up)	Rebates (0.5%)	Rewards (@$2 USD)
BTC / ETH	$25B	$125M	$0.46M
Altcoins	$7B	$35M	$1.84M

Table 1: Comparison between the dollar value of LP rewards and market maker rebates.

> Evidently, LPs receive significantly more in rebates than the present level of rewards, with BTC and ETH attracting a disproportionately larger amount (even with the new maker fee structure). Given the resiliency of these 2 markets, a consideration would be then to lower the rebates in the long run, while enhancing the rebates for altcoins.

[4] The LP Rewards program along with other DYDX incentives were introduced by the dYdX Foundation in 2021 and have since been controlled dYdX governance.

4.4 The Community Tax

As previously mentioned, fees are paid to validators and stakers. Validators take a predetermined commission of the total fees, and the remainder is distributed to their respective stakers. The community may choose to enforce an additional tax on fee income, which applies before fees are disbursed to validators. This tax, known as the Community Tax, will be set to 0% at Genesis.

The community may choose to enforce such a tax to fund additional efforts to grow, secure, or maintain dYdX Chain. As it stands, governance already has tens of millions of dollars in capital to deploy for such efforts, with millions more vesting into the community treasury every month.

However, as mentioned in Section 2, the DYDX vesting schedule is set to terminate on August 2026. At this point, no more DYDX will vest into the community or rewards treasuries. If and when the DYDX sitting in the community treasury runs out, the community will be faced with two options to continue funding operations and rewards programs:

1. Enable annual inflation of the DYDX token.
2. Enable the community tax on fees on dYdX chain.

The community tax is arguably a more sustainable source of funding for the community than enforcing an inflationary schedule on DYDX, but both options are available to the community when the time comes. Until then, there might be other reasons that governance chooses to enforce a tax. For example, a tax might be used to sustainably fund new incentives programs throughout the dYdX Chain ecosystem, such as incentives for front end or indexer operators. We discuss this in Section 7.

4.5 Negative Incentives: Slashing, & Jail

There are several mechanisms in place to disincentivize validators from misbehaving, which we place into three general buckets:

- Automatic punishments: jailing, tombstoning, and partial slashing for extended downtime or double-signing blocks.
- Manual slashing: governance proposals to slash validators caught censoring, reordering, or front-running transactions.
- Preventative measures: potential mechanisms to prevent certain types of misbehavior altogether, currently in the research and development phase.

We will discuss each below.

4.5.1 Jail, Tombstones, and Automatic Slashing

Some misbehavior can be detected automatically on dYdX Chain. These include double-signing blocks, a severe infraction that may cause instability in the network, and downtime, staying too long without signing any blocks leading to congestion and slower block times.

In either case, the punishment is enforced automatically, and is parameterized according to Table 2.

Table 2: Validator Punishment Parameters

Name	Value
Signed Blocks Window	12000 (5 hrs)
Min Signed Per Window	20%
Downtime Jail Duration	60 s
Slash Fraction Doublesign	0
Slash Fraction Downtime	0

Let's examine each type of punishment and its corresponding parameters.

- Slashing. Validators may have their stake slashed and redirected to the community pool. According to the Genesis parameters, if a validator double-signs blocks at a particular block height or fails to sign enough blocks during the specified window, they will not be slashed. That is, the slashing percentages are 0 for both infractions.

- Jailing. Validators may be removed from the "active validator set". The active validator set are the validators allowed to propose and sign blocks, and are the only ones eligible to receive fee income. Validators may return to the active set after serving their jail time. If a validator fails to sign enough blocks, they will be jailed for 60 seconds.
- Tombstoning. Validators may be permanently removed from the active validator set. Given the severity of a double-signing infraction, validators caught signing two or more blocks at the same block height will be tombstoned.

Figure 10: Bonk, go to validator jail.

Governance may choose to make these parameters more or less aggressive to further disincentivize infractions. If governance observes that validators are failing to sign enough blocks, it may choose to increase the slashing percentage from 0 to a modest amount, such as 5%. In doing so, governance increases the incentive for validators to maintain appropriate uptime. These changes, of course, might incur significant financial consequences for both validators and stakers, and must be examined and justified.

4.5.2 An Aside on Reputation

Validators fundamentally rely on reputation to scale their operations and profits. Validators generally have low percentages of "self-stake", meaning most of the staked tokens they operate with are delegated to them by the chain's stakers. Although there are several factors that affect which validator a staker chooses to stake their tokens with, a primary one is the validator's reputation. A reputable validator that is active in governance and has a history of excellent performance is likely to receive a greater share of staked tokens.

Conversely, a validator caught engaging in detrimental behavior to the chain, such as censoring, reordering, or front-running transactions is unlikely to receive much in staked tokens. That is, if the broader community is made aware of their infractions. It follows that a major tool dYdX governance has against a misbehaving validator is publicly announcing a validator's misbehavior.

4.5.3 MEV & Social Slashing

Perhaps one of the most pervasive opportunities for misconduct on dYdX Chain is MEV, or Maximal Extractable Value. For dYdX Chain, let us define MEV as any value extracted by validators or their co-conspirators by censoring, re-ordering, or front-running transactions.

Skip Protocol, in partnership with dYdX Trading's Research team, has produced the following scheme to detect and measure MEV activity from the current block proposer. The idea is simple but effective: any MEV activity will, in some way or another, re-direct profit (or loss) from one account to another. Mathematically, we can express the MEV extracted from a particular block as:

$$MEV = \frac{1}{2}\sum_{i}^{N}|PNL_i^{BP} - PNL_i^{V}|, \tag{1}$$

where i indexes the N sub-accounts on the chain, and PNL_i is account i's profit or loss at the end of the block. The superscript BP indicates that this is the actual PNL according to the transactions submitted by the block proposer, whereas V indicates the PNL that an "honest validator" would have expected.

The premise of the honest validator is simple: a node that runs the chain's canonical matching engine and does not engage in any MEV. This node, which doesn't need to participate in consensus and can simply be listening to new orders, will construct a block without engaging in any dishonest behavior. This node then compares the PNL at the end of the block with the PNL at the end of the block proposer's block. Any discrepancy may be the result of MEV activities.

Given this logic, Skip has built a dashboard that tracks this MEV metric across all validators by comparing blocks to those built by its own honest validator. You may find the dashboard here, or refer to the screenshot below.

Leveraging this dashboard and detection algorithm, community members may monitor validators and punish those found engaging in MEV. However, discrepancies seen on the dashboard don't necessarily mean a validator purposefuly censored, re-ordered, or front-ran transactions.

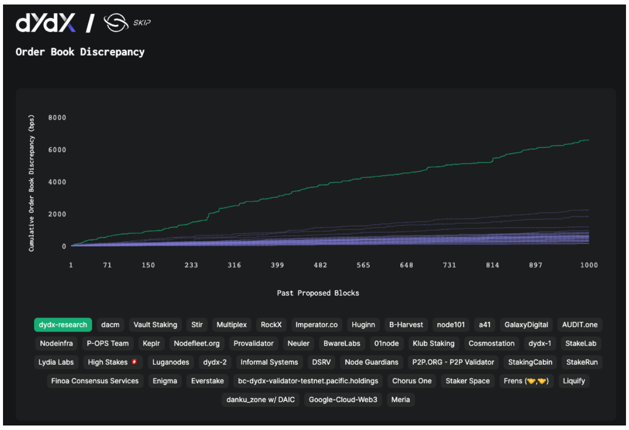


Figure 11: Screenshot of Skip's MEV dashboard taken from this announcement by dYdX Trading.

Consider the case where two buy orders of similar sizes on the same market are submitted roughly at the same time. This is not a rare occurrence: updates to the orderbook may create arbitrage opportunities that two or more traders notice and try to take advantage of. Validators receiving these orders will match them on a first-come-first-serve basis against existing orders. However, it is possible that two honest validators will receive each order at different times. Suppose order A is submitted from Brazil, and order B is submitted from Japan. A validator in South America might receive order A first, whereas a validator in Asia might receive order B first. This is a simple example of a concept known as *network jitter*: the natural discrepancy between when an order is transmitted and when it is received[5].

Due to network jitter, honest validators may exhibit non-zero MEV measurements! Therefore, an important task for those punishing dishonest validators is to adjudicate, within reason, whether observed discrepancies can be written off as network jitter.

If community members, such as the potential Slashing Review Committee, determine that a particular validator has engaged in MEV, they may propose to slash this validator. This is known as Social Slashing, and is a severe punishment for the validator. The community may choose to slash part or all of the validator's stake, affecting not only the validator but also the staker. For this reason, stakers must be careful to stake their DYDX with validators that they trust, or risk being slashed.

One potential tool to distinguish between natural and unnatural MEV measurements is to track the average MEV across all validators, or to run multiple separate "honest validators" and compare their MEV between each other. Based on these baseline measurements, MEV that is several standard deviations higher than the baseline may be deemed malicious and result in slashing.

4.5.4 Preventative Measures

There are primarily two forms of MEV that may be present in dYdX V4, which we term "plaintext-conditional" and "plaintext-unconditional" MEV. An example of plaintext-condition MEV is standard blockchain front-running, such as that seen on Uniswap: a MEV searcher sees an order, they place their own buy order in front (and possibly a sell order behind, in the case of a sandwich), and they profit from the inflated price introduced by the MEV victim's transaction. This form of MEV is commonly viewed as more harmful to users, and we believe this can be resolved via encryption technologies, such as Trusted Execution Environments or Threshold Encryption.

On the other hand, plaintext-unconditional MEV is MEV that is extracted, without regard to transaction contents. An example of plaintext-unconditional MEV is top-of-block arbitrage, whereby the latency between blocks leads to price dislocation between on-chain venues and the rest of the market, thus creating an arbitrage opportunity. Block proposers can extract this MEV by placing their own orders before others', or by selling the right to exclusive top-of-block trading to a trading entity. This form of MEV is difficult to detect and punish, since doing so requires either a collaborative block construction process, or a method for the network to veto the ordering of transactions in the block constructed by the block proposer. Generally speaking, the former requires formidably large network bandwidth and low inter-validator latency, while the latter requires nondeterministic slashing conditions (e.g., honest and potentially economically irrational majority assumptions)[6]. We look forward to listening and contributing to discussions on mitigating MEV in dYdX's future.

[5] dYdX Trading and Skip have released an updated version of the MEV Dashboard that tries to mitigate the effects of network jitter. The updated dashboard first compares the discrepancies between honest nodes to determine a "baseline" discrepancy, which is used to benchmark the discrepancy between the honest nodes and the block proposer.

[6] Although plaintext-unconditional MEV is less pernicious to everyday users than plaintext-conditional MEV, it may degrade the profitability of market makers, who are essential agents in the dYdX V4 exchange marketplace.

5
Trading Rewards

Two key incentives programs for dYdX v3 were Trading Rewards and Liquidity Provider (LP) Rewards. Recent changes have led to a transition away from LP Rewards and towards Market Maker rebates, which we touched on briefly in Section 4. Conversely, trading rewards will remain a cornerstone of dYdX's ecosystem incentives with dYdX v4. The new module boasts two key parameters that the community must manage effectively to promote growth in the ecosystem, while avoiding excessive spending. In this section we discuss the new trading rewards mechanics and provide a tentative framework for managing them moving forward.

The trading rewards module has undergone several changes since its inception in 2021. In the following subsections, we will provide a brief history of trading rewards on dYdX v3, an overview of the new trading rewards mechanism on dYdX v4, and finally an experimental design framework for managing v4 Trading Rewards parameters. Part of our framework hinges on preventing wash traders from profitably farming the trading rewards module. Our wash trading analysis can be found in Appendix C.

5.1 A Brief History of v3 Trading Rewards

At its inception in August of 2021, dYdX's Trading Rewards program would disburse ethDYDX according to the following formula:

$$r_i = R \cdot \frac{w_i}{\sum_n w_n}, \tag{2}$$

where r_i is the rewards disbursed to the i^{th} trader, w_i is that trader's "weight" compared to other traders, and R is the total rewards being distributed over the 28-day measurement period, called an epoch. A trader's weight was calculated as:

$$w_i = f^{0.7} \cdot d^{0.3}, \tag{3}$$

where f is the fees paid by trader i over the epoch, and d was the average open interest they held. This weight function, commonly known as a Cobb-Douglas utility function, aimed to increase the number of outstanding derivatives contracts held on dYdX v3.

> "After the launch of the token, dYdX trading volumes skyrocketed to over $2B / day."
> — The History of dYdX (so far) - Antonio Juliano, CEO dYdX

This early iteration of the Trading Rewards liquidity mining program was successful in driving exchange volume and open interest and garnered attention from institutional and retail traders alike. However, it had one undesirable side-effect: it was susceptible to "farming".

Sophisticated agents quickly identified ways to extract more value from the trading rewards program than they spent in fees in a given epoch. An extreme example of this is wash trading: throughout the earlier epochs of the Trading Rewards program, many addresses were caught trading between two accounts held by the same entity in order to avoid paying the bid-ask spread. The dYdX Foundation, the progenitors of the ethDYDX token and the Trading Rewards program, quickly identified this problem and blacklisted addresses caught wash trading.

However, wash trading was not the only strategy traders used to farm dYdX's rewards program. In a research paper published in early 2022, Xenophon Labs identified strategies for how traders might profit from the rewards program by optimizing market-neutral positions.

Our analysis pointed to a few undesirable properties of the Trading Rewards program:

- The complexity of the Cobb-Douglas function benefited skilled traders that (a) had the resources to maintain high open interest throughout an epoch and (b) had the technical sophistication to avoid liquidations and optimize their fees paid to maximize profits. This further incentivized the creation of leveraged, hedged positions that maximized open interest without accepting any market risk. The profits of these sophisticated traders came at the expense of retail traders who ended up receiving less rewards.

- The program seemed to be attracting “mercenary” traders, instead of “sticky” or loyal users; as the price of ethDYDX plummeted throughout late 2021 and early 2022, the fees paid on dYdX v3 plummeted accordingly. See Fig. 12. Given that the ethDYDX supply is limited, users acquired through the Trading Rewards program should ideally remain on the platform even as incentives declined.

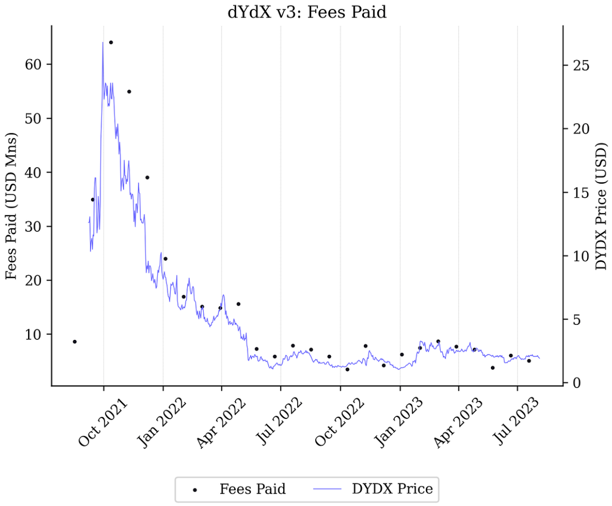


Figure 12: This plot compares the fees paid on the dYdX v3 platform to the price of ethDYDX token. Notice that fees paid are highly correlated with ethDYDX token price, indicating that a large cohort of traders are sensitive to the Trading and LP rewards programs.

In the months that followed, several governance proposals were submitted to address both concerns. See their chronology below:

- April 2022: Increase the weight of fees, decrease the weight of open interest in the Trading Rewards formula. Proposed by Xenophon Labs. See the discussion here.
- August 2022: Simplify the rewards formula to only account for fees paid. Proposed by SLN Capital. See the discussion here.
- September 2022: Reduce trading rewards by 25%. Proposed by Wintermute governance. See the discussion here.
- February 2023: Further reduce trading rewards by 45%. Proposed by Wintermute governance. See the discussion here.

The simplification of the rewards formula, first by reducing the weight of open interest, then by eliminating open interest entirely, served to make the program more equitable for retail traders, and reduce the marginal advantage (or edge) available to sophisticated traders in maximizing their profits from rewards. The reduction in trading rewards expenditure served to make the program more sustainable as the protocol matured and more evidence was gathered that the program was largely attracting mercenary volume.

5.2 Overview of v4 Trading Rewards

An opportunity arose to improve upon the v3 Trading Rewards program with the launch of dYdX v4[7]. First and foremost, while trading rewards on dYdX v3 were paid in 28-day cycles (epochs), v4 trading rewards will be paid at the end of every block, or roughly every two seconds. That is, each user is now immediately rewarded for paying fees to the protocol.

Each block, a predetermined amount of DYDX is emitted to the rewards module to be distributed as rewards. Let’s denote this amount as E, for emissions. At the end of the block, the following amount of DYDX is disbursed to traders by the trading rewards module:

$$A = \min\left(C \cdot \frac{S}{p}, T\right), \tag{4}$$

[7] See this announcement by dYdX Trading on the new rewards formula, or this brief overview by Xenophon Labs.

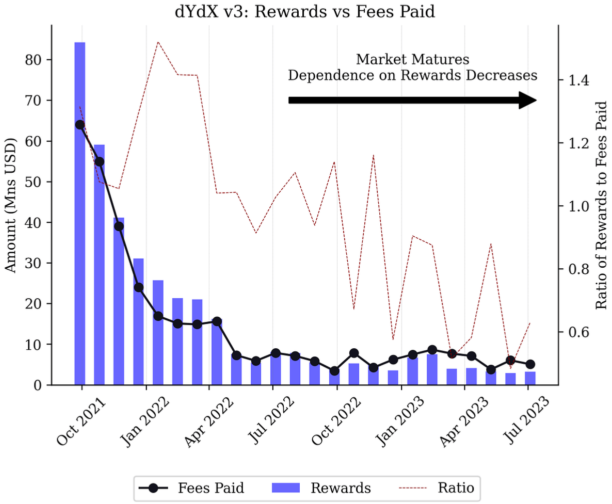


Figure 13: This plot compares the fees paid on dYdX v3 to the amount spent in rewards. Notice that dYdX was paying more in rewards than it was earning in fees throughout earlier epochs. As the market matured and several governance proposals amended the rewards program, trading activity became less sensitive to the value of rewards being disbursed.

where A is the total amount of DYDX disbursed, $C \in [0, 1]$ is a community-owned parameter (originally set to 0), S is the total amount of fees paid to the protocol (adjusted by maker rebates), p is the oracle price of DYDX token, and T is the total amount of DYDX sitting in the rewards module. Notice that T is the sum of the per-block emissions E and the leftover DYDX that was not disbursed in the previous block.

Herein lies a key difference between v3 rewards and v4 rewards. On dYdX v3, all emissions to the Trading Rewards module would be distributed to traders regardless of how much was paid in fees. As we saw on Fig. 13, this led to the protocol often disbursing more in rewards than it received in fees, particularly throughout earlier epochs when sophisticated traders could optimize their open interest to profit off the rewards program.

On dYdX v4, the rewards distributed at each block are limited not only by the amount of DYDX available in the rewards module, T, but also by the total amount of fees paid during that block, S. By managing the C parameter, the community controls the maximum proportion of fees that may be rebated back to traders as DYDX rewards, and by ensuring that $C < 1$, the protocol never pays more in rewards than it earns in fees.

> “Trading rewards should limit the protocol overspending on trading activity”
> — v4 Deep Dive: Rewards and Parameters

At a high level, the C parameter acts as a simple pricing lever for the community to make trading cheaper on dYdX v4 without damaging validator incentives. Instead of lowering fees, which would come at the expense of the chain's stakers and validators, the community may choose to enforce a high C parameter.

At Genesis, the C parameter will be set to 0%. The community may then choose to increase the C parameter to enable trading rewards. The emissions to the trading rewards module have not yet been determined, and will depend on the amount of DYDX credited to the rewards vester account on dYdX Chain, which we discussed in Section 3.6.2.

Given that trading rewards consume a major portion of DYDX expenses (i.e., inflation) a crucial responsibility for the community is to adequately manage both the emissions to the module, and the maximum trading fee “discount” provided by the module, parameterized by C. In what follows, we provide a tentative framework for managing trading rewards parameters based on the principles of experimental design.

5.3 Managing Trading Rewards Parameters

The thesis for our parameter-setting framework is simple: *it is exceptionally hard to optimize a protocol's parameters without rich empirical data*. We believe the key to effectively managing dYdX Chain parameters, particularly trading rewards parameters, will be to construct these rich, empirical datasets through robust hypothesis testing. That is, we must make changes to trading rewards parameters and observe their effects on some key protocol metrics. Specifically, our framework aims to optimize Trading Rewards parameters against the program's

Gross Profits and/or Return On Investment (ROI).

By iteratively modifying Trading Rewards parameters and observing how users react, we may build empirical user behavior models that we then leverage for future parameter adjustments. Ultimately, this experimental design framework will allow us to tend towards a locally optimal configuration of Trading Rewards with respect to our key metrics.[8]

The primary goal of this framework is to enforce statistical rigor when making and assessing changes to rewards programs. Previous proposals by Xenophon Labs and other dYdX contributors may have been directionally correct, but have not placed enough emphasis on a robust testing framework to (a) motivate the proposal, and (b) assess whether the proposal successfully improved a particular metric.

5.3.1 Metrics

We consider two key metrics that we believe lie at the core of the trading rewards program: gross profits and ROI. Gross profits are merely the protocol's revenue (or fees paid) minus the protocol's costs (or rewards). We formalize gross profits as:

$$\text{Gross Profits} := \text{Fees Paid} - \text{Rewards Emitted}. \tag{5}$$

Denote $E = \text{Rewards Emitted}$ and $f(E, C) = \text{Fees Paid}$. Notice that fees paid is a function of both trading rewards parameters. We can rewrite gross profits as:

$$\text{Gross Profits} := f(C, E) - E. \tag{6}$$

Similarly, ROI can be expressed as:

$$\text{ROI} := \frac{f(C, E) - E}{E}. \tag{7}$$

The effective management of rewards parameters aims to maximize one of these metrics by gathering data on the curve $f(C, E)$. We can formalize this problem as:

$$\begin{aligned} &\text{maximize} : \text{metric} \\ &\text{subject to} : 0 < E < \text{Budget} \end{aligned}$$

Whether to maximize profits or returns from the trading rewards program is a complex decision. Assuming that there is a positive relationship between the amount of DYDX emitted to the trading rewards program and the amount of fees being paid, a profit-maximization scheme would likely demand a greater investment into the trading rewards program. During the first several months of dYdX v4, the community might reasonably choose to spend more DYDX on an aggressive trading rewards program to accelerate growth and dominate the perpetuals market. However, as the protocol matures and the limit on DYDX inflation looms, the community might choose to pivot into an ROI-maximization scheme, which would likely demand a reduced expense on the Trading Rewards program to avoid spending DYDX past the point of diminishing returns.

5.3.2 Hypothesis Testing

Lets begin with a motivating example for how hypothesis testing may lead to significant efficiency improvements in the trading rewards program. Suppose the current trading rewards parameters are $\{C_0, E_0\}$, and we are considering lowering C from C_0 to C'.

$$\begin{aligned} H_0 &= \text{Lowering } C \text{ from } C_0 \text{ to } C' \text{ has no statistically significant impact on the program's ROI.} \\ H_a &= \text{Lowering } C \text{ from } C_0 \text{ to } C' \text{ has a statistically significant impact on the program's ROI.} \end{aligned}$$

More formally, we will be measuring the observed ROI during some sampling period before and after our change. For example, we may measure the ROI of the program at every block before

[8] In dYdX v3 the Trading Rewards parameters were changed only a handful of times, with little statistical analysis being published on the effects of these changes on trading volume. We are proposing this framework to avoid this pitfall with dYdX v4, and encourage the community to actively manage trading rewards parameters to nurture the ecosystem's growth and avoid over or under spending on the program.

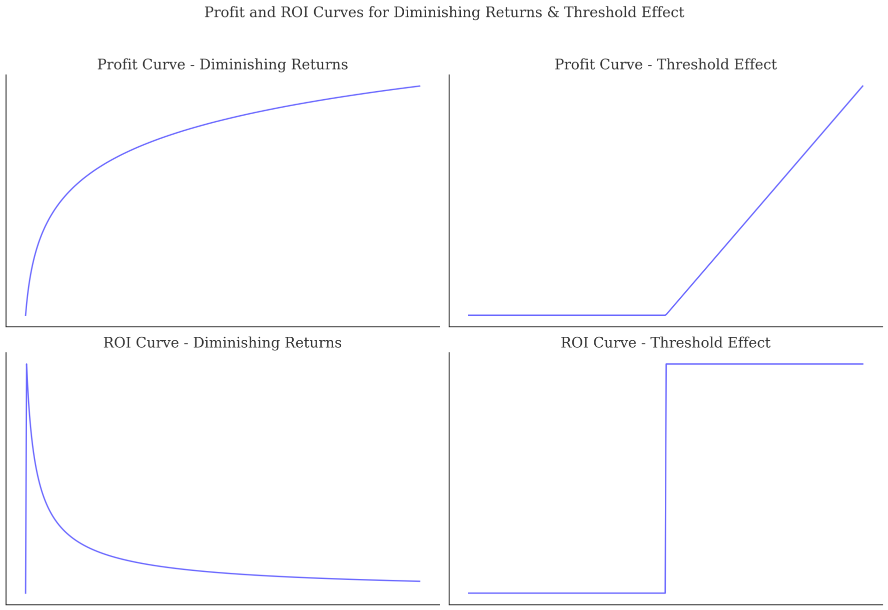


Figure 14: Simple examples for what the profit and ROI curves on the trading rewards program might look like.

we lower C for N blocks, comprising a period of approximately 2 weeks. We will repeat these measurements for N blocks following the change to the C parameter. Then, we may conduct a statistical test such as a paired t-test to determine whether the change to the program's ROI was statistically significant, accounting for the mean difference in ROI before and after the change, as well as the variance in measurements. If the results of our paired t-test fall within our confidence interval, which we may set to 95%, then we may determine that lowering C does, indeed, lead to a meaningful change in the ROI of the trading rewards program.

Based on these results, we may proceed with some predetermined *action*.

- **Success:** If lowering C led to an improvement in the trading rewards program, we may choose to persist the change, and potentially continue to lower C in the future.
- **Failure:** If lowering C leads to a decrease in the program's ROI, we may choose to revert our change.
- **Inconclusive:** If lowering C led to inconclusive results (i.e., we fail to reject the two-sided null hypothesis), then we may choose to wait and gather more data.

Although this is a simple example, it captures the essence of our experimental design framework:

1. **Parameter.** Choose a single variable to modify. Modifying multiple variables could lead to ambiguous conclusions.
2. **Metric.** Choose an appropriate metric to test, such as return on investment.
3. **Test.** Determine the statistical test to be used, such as a paired t-test to compare measurements across before-and-after samples.
4. **Action.** Determine what to do if
   a. the parameter change led to an improvement in the metric: persist the change.
   b. the parameter change led to a deterioration in the metric: revert the change. Requires an additional governance proposal.
   c. the null hypothesis was not rejected: extend the measurement period, or revert the change.

Intuitively, this hypothesis testing framework acts as a gradient-descent approach to optimizing the trading rewards module: we apply small changes to each individual parameter, if we observe that the change improves the appropriate metrics, we persist the change and, in the future, further change the parameter in the same direction. This way, we can gradually "walk" towards an optimal parameter configuration.

We consider the following constraints to our hypothesis testing framework:

- **Budget**. The community may choose to enforce a maximum budget on the emissions to the trading rewards module.
- **Maximum Changes**. The community may choose to enforce a maximum change to each parameter. For example, the C parameter may not be changed by more than 5% at a time.
- **Frequency**. The community may choose to enforce a maximum frequency for running these hypothesis tests. For example, these tests may not be run more frequently than once a month.

5.3.3 Limitations

There is one obvious limitation to this approach: fees paid to the protocol are not exclusively functions of trading rewards parameters. This has two corollaries:

- **Spurious correlations:** hypothesis tests might indicate that a particular change was successful when the true reason a metric improved is due to a change in an external variable. The opposite might also be true, where a change to a parameter would have otherwise led to an improvement in a metric, but this was superceded by the effects of changes to an external variable. The proposer of a particular test must be transparent about confounding variables and how they may have affected the results of the test.
- **Non-Stationary Optimization:** the optimal configuration of trading rewards parameters may change over time due to external market conditions or user preferences. For example, it might be optimal for the community to support higher emissions on trading rewards throughout the early months of the exchange, and over time reduce these emissions as the product matures. The community should regularly review the program's metrics and, based on shifting market conditions, suggest adjustments to the parameters as needed.

5.3.4 DYDX Price and Elasticity

One question the reader might have is how one would decide to experiment with higher or lower parameters. One way a community member might make this decision is by using a simpler measurement on the elasticity of traders to the trading rewards program.

The community might be able to naturally observe whether traders on dYdX v4 are elastic or inelastic by comparing fees paid to the protocol with DYDX price. As DYDX price fluctuates, the dollar value of per-block rewards also fluctuates. If, over a meaningful period of time, a reduction to DYDX price does not lead to a reduction to fees being paid, the community may be fairly confident that demand on dYdX Chain is inelastic.

Over time, data comparing fees paid to the protocol with the price of DYDX might be used to construct a curve $f(E, C, p)$, where p is the price of DYDX. Assuming no changes to E, C, the curve $f(p)$ could offer insights on the elasticity of demand at different DYDX prices.

In the extremes, we might observe that traders are completely inelastic to the trading rewards program, in which case we might gradually reduce the program's emissions, test whether this hypothesis is true, and eventually wind down the program entirely.

Of course, we find this would be a very unlikely outcome! In all likelihood, traders will be sensitive to both trading rewards parameters and to the price of DYDX. A more nuanced possibility is that, if DYDX price rises sharply, there is a point of diminishing returns where, despite increases in DYDX price (and therefore an increase in the dollar value of rewards distributed) fees don't continue increasing at the same rate. In this case, the community might choose to reduce emissions to avoid crossing the point of diminishing returns.

5.4 On Wash Trading

One additional consideration for managing the trading rewards program is preventing wash trading from being profitable. At its surface, trading rewards is not a profitable wash trading opportunity since traders can never receive more in rewards than they pay in fees. However, traders on dYdX Chain might also be stakers. As stakers, they receive part of the fees paid to the protocol as staking rewards. A staker that commands a sufficient proportion of the chain's stake might be able to profitably wash trade on dYdX Chain, receiving more in trading plus staking incentives than they pay in fees.

Additionally, these large stakers don't necessarily need to engage in wash trading to benefit from this dynamic. These stakers might simply be large traders on the chain, pushing significant volume from profitable trading strategies, or they might be sophisticated market makers with a large DYDX allocation.

In Appendix C, we discuss the profitability of self-trading with respect to trading and staking rewards, and the implications for setting trading rewards parameters.

5.5 Potential Improvement: Market Discrimination

Effective incentives programs often aim to identify which users are most price-sensitive and treat them accordingly. For example, ride-sharing apps might identify which users are most elastic to surge pricing and offer them additional discounts to keep them on their platform.

Although cryptocurrency protocols are often unable to discriminate between users, a problem referred to as "Sybil resistance", they may discriminate between the activities each user chooses to participate in.

On dYdX Chain, a key differentiating factor between users is the market they choose to trade in. In a study conducted by dYdX community members 0xCLR and 0xCChan, volume flowing through the BTC and ETH markets was found to be less elastic to trading fees than alternative, smaller markets like XRP or SOL. This creates an opportunity to price-discriminate between traders (or, more accurately, trades) flowing through these different markets, charging them according to their observed elasticity.

Similarly, it might be prudent to increase or decrease the Trading Rewards allocated to different markets on dYdX Chain. For example, allocating a smaller share of rewards to the protocol's largest, most established markets might lead to negligible impact on the fees being paid to the protocol, since traders in these markets are not as sensitive to trading rewards. In turn, this would lead to an improved ROI for the program.

At launch, the Trading Rewards program does not discriminate between markets. However, as dYdX Chain matures and engineering resources are freed up to conduct potential optimizations on incentives programs such as trading rewards, we might find it profitable to modify the trading rewards mechanism to incorporate discriminating factors such as markets.

6

Markets

dYdX v4 empowers the community to control market listings and market parameters through on-chain governance proposals. The timely listing of new markets is a crucial component of growth in the fast-paced industry of decentralized finance, and requires sophisticated risk-management to ensure market parameters reflect the risks of underlying tokens. Furthermore, dYdX v4 will eventually launch a permissionless listings program, which will enable any user to list a new market by specifying its oracle, market parameters, and perhaps providing some initial liquidity. In this section we discuss initial market listings for dYdX v4, the community's responsibility in listing new markets and managing market parameters, and a few thoughts on permissionless listings design. The permissionless listings ideas presented here are the product of discussions with several community members at dYdX, and other DeFi protocols.

6.1 Market Listings Overview

Listing new markets, closing existing markets, and updating market parameters are all done via governance proposals on dYdX v4. This entails a large responsibility for the dYdX community to vote on market listing proposals and ensure market parameters are kept up to date with market trends and liquidity.

To service these responsibilities, the dYdX community may choose to establish a dedicated markets subDAO, or onboard sophisticated service providers.

6.1.1 Initial Market Listings

dYdX v4's initial markets are displayed in Appendix B.2.1, and are largely based on the successful markets of dYdX v3. These include BTC, ETH, OP, LINK, as well as newer tokens such as WLD, BLUR, and PEPE.

6.1.2 Market Parameters

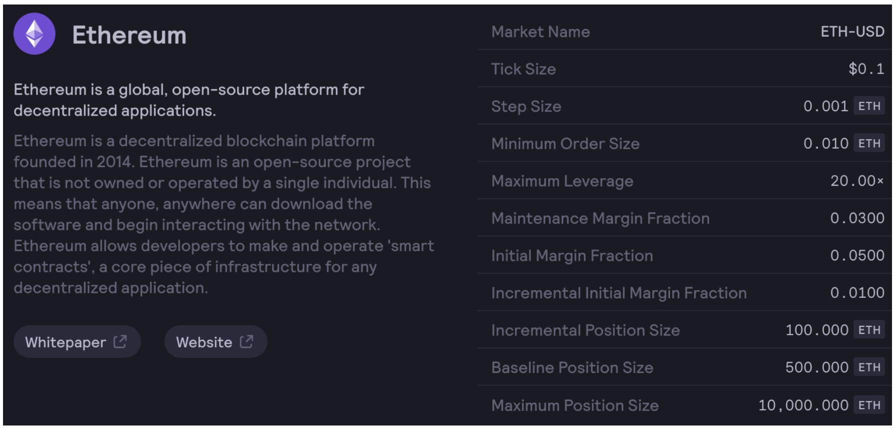
Each market listing carries with it a few market parameters, including:

- **Tick sizes:** The smallest change in market prices considered by the exchange.
- **Oracle:** The source[s] of a market's underlying spot price, such as Binance, OKX, or other spot exchanges.
- **Liquidity Tiers:** The liquidity tier a market belongs to, either small cap, mid cap, or large cap. These liquidity tiers are appointed on a discretionary basis, and determine the minimum and maintenance margin requirements for positions held in the market, among other things.

The market parameters for the ETH market on dYdX v3 are depicted in Fig. 15.

6.1.3 Market Risks

All three market parameters outlined previously-tick sizes, oracles, and liquidity tiers-are crucial in maintaining a healthy derivatives exchange. Tick size width affects the liquidity profile of different markets, and affects the profitability of both makers and takers on the exchange. Oracles are crucial for reporting accurate prices; in the worst-case scenario, a user listing a malicious oracle could sway prices in their favor, causing financial harm to all traders taking the other side of the user's position. Finally, liquidity tiers are key for determining margin requirements, which themselves are a highly sensitive parameter. Setting margin requirements too high can be stifling for traders, encouraging them to trade on alternative derivatives exchanges where they can acquire more leverage. Alternatively, low margin requirements can lead to unprofitable or missed liquidations if there is insufficient liquidity to close underwater



Ethereum

Ethereum is a global, open-source platform for decentralized applications.

Ethereum is a decentralized blockchain platform founded in 2014. Ethereum is an open-source project that is not owned or operated by a single individual. This means that anyone, anywhere can download the software and begin interacting with the network. Ethereum allows developers to make and operate 'smart contracts', a core piece of infrastructure for any decentralized application.

Market Name	ETH-USD
Tick Size	$0.1
Step Size	0.001 ETH
Minimum Order Size	0.010 ETH
Maximum Leverage	20.00×
Maintenance Margin Fraction	0.0300
Initial Margin Fraction	0.0500
Incremental Initial Margin Fraction	0.0100
Incremental Position Size	100.000 ETH
Baseline Position Size	500.000 ETH
Maximum Position Size	10,000.000 ETH

Figure 15: ETH market parameters for dYdX v3.

positions.

Ensuring these parameters are set appropriately is a challenging task. Community members or service providers must monitor positions and tune parameters according to shifting market forces. If a certain market becomes less liquid, for example, it might be appropriate to raise its margin requirement, and vice-versa.

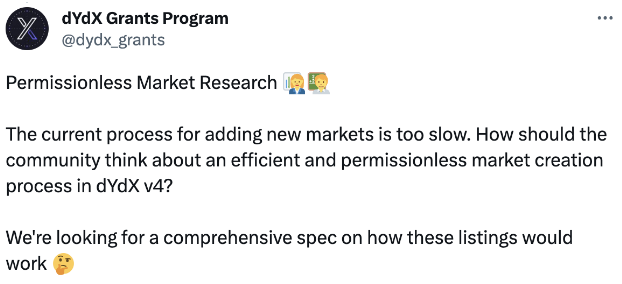
6.2 Permissionless Markets

Disclaimer: This discussion is the product of several conversations with community members at dYdX and the broader Cosmos ecosystem; it makes a few assumptions regarding the design of dYdX Chain.

Under a permissionless listings paradigm, any market can be listed, with any oracle, and any set of market parameters. Of course, the community may choose to enforce boundaries on parameters, or require that oracles originate from certain whitelisted oracle providers such as Chainlink. This permissionless paradigm allows anyone to identify new and attractive markets and list them on dYdX, bringing additional supply and demand to the exchange. This might meaningfully improve dYdX's ability to capture new and emerging markets, acquiring new users and increase dYdX's overall market share in the derivatives space.

> “Permissionless pool creation, within Governance permissioned boundaries, interacted with through permissioned frontends”
>
> — Johnny Wyles, governance lead at Osmosis, on Osmosis' permissionless listings paradigm.

To that end, permissionless listings have been successful components of growing many AMMS, most notably Uniswap and Osmosis. Uniswap in particular observed significant growth over the last several years due to its ability to quickly onboard new pools, and capture that market share.



dYdX Grants Program
@dydx_grants

Permissionless Market Research 👩‍🏫👨‍🏫

The current process for adding new markets is too slow. How should the community think about an efficient and permissionless market creation process in dYdX v4?

We're looking for a comprehensive spec on how these listings would work 🤔

Figure 16: dYdX Grants Program's Tweet on Permissionless Listings Research.

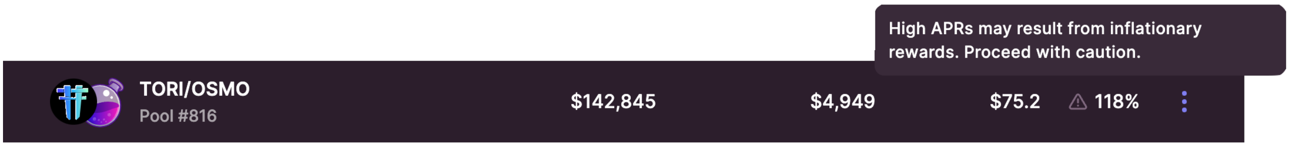
However, permissionless listings might also create incentives for listing “malicious markets”, where the entity listing the market controls either the oracle or the supply of the underlying token. Furthermore, permissionless listings allow the same underlying token to be listed over several markets, fragmenting liquidity for long-tail assets. We wish to mitigate all these effects with the sound design of a permissionless listings framework. The first step in doing so is to distinguish between *permissionless markets* and *core markets*.

We will refer to those listing permissionless markets as Sponsors.

6.2.1 Core and Permissionless Markets

Permissionless markets have few security assumptions; traders must be cautious of potential scams or attacks. These markets are similar to the "unverified" pools listed on Osmosis Zone[9]. Core markets, on the other hand, have either been listed by governance or were previously permissionless markets that have since been upgraded. dYdX may choose to distinguish between core and permissionless markets both in terms of the user experience, and in terms of the protocol's various liquidation and incentives mechanisms:

1. **UX:** Provide clarity for front ends operators on how they might prioritize the display of different markets. For example, Osmosis Zone allows users to hide permissionless markets using a simple toggle button. Alternatively, permissionless markets might be displayed on separate tabs or separate front ends entirely, as used to be the case with Osmosis Frontier.
2. **Incentives, Insurance, and Margin:** Permissionless markets might be subject to a number of inefficiencies or malicious attacks, discussed below. To avoid the risk of contagion, we might isolate permissionless markets from the rest of the protocol. For example, we might launch permissionless markets with isolated margin and insurance funds.



High APRs may result from inflationary rewards. Proceed with caution.

TORI/OSMO
Pool #816
$142,845
$4,949
$75.2
⚠ 118%

Figure 17: High APR warning on Osmosis, a tool to prevent retail LPs from falling for scams. Note: we are not making any statement about the token being depicted in this figure.

6.3 Permissionless Market Risks

To motivate the discussion for designing permissionless listings, we first discuss some of the associated risks. Particularly, we consider how permissionless listings may be leveraged to attack or scam dYdX users using tampered oracles or tampered token supplies. Furthermore, we consider how permissionless listings might fragment liquidity across the exchange.

6.3.1 Tampered Market Listings

Consider Osmosis, one of the most successful application chains on Cosmos. Osmosis launched a permissionless listings program along with a permissionless incentives program. Permissionless incentives enabled the team listing a new pool to incentivize liquidity, at no additional cost to the Osmosis treasury or OSMO inflation. It also, however, enabled malicious actors to list pools for obscure projects with enourmous incentives. This lead to several pools being listed with APRs in the 100%+ range, indicating that one of the tokens in the pool has a highly inflationary schedule. Liquidity providers are then tricked into LP'ing into the pool to grab some of the APR. To do so they must purchase a large quantity of the underlying token, at which point the malicious sponsor "rugs" the project by market selling a large portion of the circulating supply.

Osmosis has considered several approaches to mitigating the damage from malicious listings, some of which are discussed later in this section. One mitigation tool is a listing fee (currently at 100 OSMO), as well as several cosmetic approaches to warn retail users browsing the Osmosis Zone front end that astronomical APRs are indicative of potential scams, shown in Figure 17. See this forum post for the ongoing discussion on Osmosis.

> "A review of the last 80 liquidity pools created (Pool #938 through Pool #1018, which are roughly all those that have been created since the beginning of March), **found that 55 of them (or 80%) to be either scam, spam, or, predatory**."
>
> — Osmosis Forums: Proposals Addressing SCAM Pools

However, these approaches have a few shortcomings:

- Potential gains from successful attacks can far exceed the fixed listing fee.
- Cosmetic additions to the UI may not be adopted by all front ends if front ends are decentralized.
- Cosmetic additions to the UI often rely on some threshold conditions such as APRs above 75% being flagged; malicious actors can identify these conditions and subvert them.

The line between mitigating malicious attacks and stifling the growth of permissionless listings is a thin one. Let's first consider some of the potential attacks that might be levied via permissionless listings.

[9] Unverified pools on Osmosis were previously listed on Osmosis Frontier instead. On September 2023, Osmosis Frontier was merged with Osmosis Zone, the primary Osmosis front end, to consolidate and simplify the user experience.

Oracle Manipulation

The Sponsor lists a new market with an oracle feed that they control. They may then take a LONG or SHORT position on the market, and change the oracle price to benefit them. They may profit from this manipulation either by earning the funding rate, or by closing their position at a profit as traders exit the market.

Token Supply Manipulation

Similar to Oracle manipulation, a sponsor might list a market for a token for which they control a large portion of the supply. This sponsor may then short the perpetual, and conduct a firesale of the token on relevant spot exchanges. As the spot price of the token falls, the sponsor profits from their short position.

Denial-of-Service Attacks and Spam

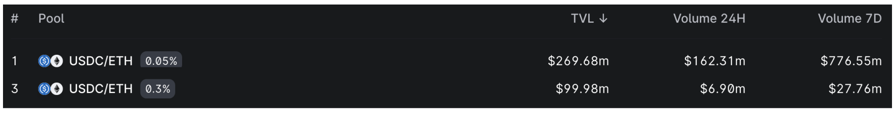
A less pernicious attack is spamming the network with permissionless markets. This might be done maliciously to damage the user-experience for permissionless listings and increase the costs of operating the chain. At the time of writing, gas fees are $0, users can place long-term orders that are incorporated into blockchain state. These stateful orders come with rate limits on a per-market-per-account basis; for example, a user with $20 of collateral can place no more than one order in each market at a time [1]. That is, the cost of capital for spamming the network with one order on every market on every block is $20. If there are 50 markets, then it would only require $20 to spam the network with 50 orders every block.

Chain spam risk may arise from a low barrier to list markets. For this reason, Osmosis and other permissionless protocols implement listing fees to deter users from spamming new markets.

6.3.2 Liquidity Fragmentation

Aside from potential scams or attacks on permissionless markets, we must consider the possibility that perpetuals liquidity for underlying tokens becomes fragmented. On dYdX v3 there is exactly one market for each token, with parameters being optimized largely by dYdX Trading. Under a permissionless listings paradigm, there might be several markets for the same token, some with different oracles, different tick sizes, etc..

> “We document significant liquidity fragmentation in 32 out of 242 asset pairs in our sample, which account for 95% of liquidity committed to Uniswap v3 smart contracts and 93% of trading volume. For each of the fragmented pairs, trading consolidates on two pools with adjacent fee levels: either 1 and 5 basis points (e.g., USDC-USDT), 5 and 30 basis points (ETH-USDC), or 30 and 100 basis points (USDC-CRV).”
>
> — *Liquidity fragmentation on decentralized exchanges*, by Lehar et al., [2],



#	Pool	TVL ↓	Volume 24H	Volume 7D
1	USDC/ETH 0.05%	$269.68m	$162.31m	$776.55m
3	USDC/ETH 0.3%	$99.98m	$6.90m	$27.76m

Figure 18: Liquidity fragmentation in the Uniswap v3 market for the USDC/ETH pair. Notice that around 27% of the TVL is held in the higher fee market. Snapped from the Uniswap user interface on August 9th, 2023.

There have been several studies on the fragmentation of liquidity on permissionless AMMs like Uniswap, where different fee and tick sizes attract different profiles of Liquidity Providers. Lehar et al. [2] found that large LPs tend to focus on pools with lower fees, where they observe more demand and therefore accrue more fees. Simultaneously, this incurs a number of fixed costs as these LPS must rebalance their positions and pay corresponding gas. Smaller LPs, for whom fixed rebalancing costs like gas fees, tend to concentrate on pools with higher fees and lower trading volume. As demand eats away at the liquidity on lower fee pools, orders begin to be routed to pools with higher fees. This “economy of scale” effect causes liquidity fragmentation.

As we will discuss, upgrading permissionless markets to core markets might help consolidate liquidity for particular tokens on dYdX v4. This signals to makers and takers that this market has additional security assumptions, such as reasonable tokenomics and oracles for the underlying token. Permissionless markets might then be an experimentation phase, where market forces determine which are the best parameters for particular markets, before governance decides which one[s] to upgrade.

However, this does not avoid the fact that some makers and takers might prefer markets with different parameters, and that different equilibria might arise between an XYZ-PERP market with a small tick size, and an XYZ-PERP market with a large tick size. A natural question might then be: how will makers and takers optimally route their orders between numerous potential markets with different parameters?

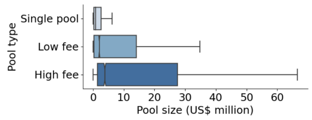


Figure 19: Box plot for empirical data on Uniswap v3 pools by Lehar et al. [2]. The plot shows that, for pools with a low fee and high fee option (e.g. 30 bps vs 100bps), the high fee pools observe significantly more liquidity, with this discrepancy being exacerbated for larger pools.

6.4 Designing Permissionless Listings

We now overview some simple design considerations for permissionless listings with two key objectives in mind:

- **Growth:** Permissionless listings should foster growth on dYdX v4, this might be done by enabling external incentives, and making the listing process as friction-free as possible.
- **Isolation:** Given their inherent risks, the community might choose to prevent permissionless markets from integrating with protocol-wide mechanisms, such as cross-margining or the liquidation insurance fund.

Whether these considerations do or do not come to fruition on the final design of the permissionless listings program will depend on dYdX Chain governance. We outline them in this report to inform the reader on the various tools at dYdX's disposal to minimize risks and losses to dYdX users.

6.4.1 Isolated Margining

Cross margining allows margin traders to deposit collateral that is shared across multiple positions. This means a trader might deposit 1,000 USDC, and use it to open a LONG BTC-PERP position worth 10,000 USDC, and a SHORT ETH-PERP position worth 10,000 USDC, placing their overall leverage at the 20x maximum. If both BTC and ETH appreciate in value, then the user can offset their losses on their SHORT ETH position against their gains on their LONG BTC position. Without cross-margining, the user might get liquidated on the SHORT ETH position despite gains in their LONG BTC position. On dYdX v3, cross-margining was enabled by default, with isolated margining being possible using sub-accounts.

A concern with permissionless markets is contagion due to cross margining: a user might have several healthy positions open in core markets, and one risky position in a permissionless market. If the permissionless market experiences an oracle attack, then the user might be liquidated, which could affect their positions in other markets. To avoid cascading liquidations between permissionless markets and core markets, we might require all permissionless market positions be made with isolated collateral. This could be done, for example, by using the sub-accounts infrastructure.

6.4.2 Liquidation Insurance

On dYdX v3, price movements lead to unprofitable or missed liquidations on dYdX, the negative balance is discounted from a protocol-wide insurance fund. Similarly, excess profits from timely liquidations count towards the global insurance fund. Assuming a similar structure exists for dYdX v4, a natural question is whether unprofitable liquidations on permissionless markets should be discounted from the global insurance fund.

Like enabling cross margining, enabling the global insurance fund on permissionless markets could create contagion between permissionless markets and core markets. Consistent scams and attacks on permissionless markets might deplete the insurance fund, hampering the ability of liquidators (e.g. the protocol's validators) from performing unprofitable liquidations, leading to missed liquidations and the accrual of "bad debt". Due to minimal security assumptions on permissionless markets, dYdX governance might choose to remove them from the global insurance fund entirely.

6.4.3 External Incentives

As discussed in Section 4, the LP rewards program popularized on dYdX v3 is being discontinued in favor of a market maker rebate program. However, we may consider the implementation of an External Incentives program similar to those implemented on Osmosis.

Xenophon Labs has previously discussed how LP rewards might be brought "fully on-chain" in a previous report, by modifying the rewards formula to be based exclusively on volume. Assuming the necessary logic were implemented in the dYdX chain codebase, the community may consider enabling the sponsors of any market to include a stream of tokens to be regularly emitted as rewards, both to traders and liquidity providers in their specific permissionless market.

For example, Sponsor A is interested in listing a market for XYZ-PERP on dYdX v4. Perhaps, Sponsor A is the development team behind token XYZ, or the corresponding DAO, and they believe that perpetuals trading on their token will improve visibility, price discovery, and liquidity on their new token. With that in mind (and perhaps following a governance vote on the XYZ DAO), Sponsor A lists XYZ-PERP, and in that process locks 1M XYZ token to be disbursed as trading rewards and an additional 1M XYZ token to be emitted as volume-based LP rewards for the XYZ-PERP market over the course of 6 months. In that time, the additional trading incentives encourage traders to open positions on XYZ-PERP, and encourages existing market makers to provide the necessary liquidity in that new market. This avoids Sponsor A from having to solicit over-the-counter (OTC) deals with market makers to provide liquidity for their new project, and enables them to stimulate initial trading activity for their derivative.

6.4.4 Upgrading Markets

Ideally, permissionless markets are quickly upgraded to core markets once they achieve a certain amount of popularity[10]. Once upgraded, traders and market makers get to enjoy the benefits of cross-margining, global liquidation insurance, and the additional security assumptions that the oracles and tokenomics for the underlying token are sound. Furthermore, core markets might help consolidate liquidity, and avoid retail users from being scammed.

To that effect, we might consider two paradigms for quickly upgrading permissionless markets to core markets:

1. **Automated:** Markets are automatically upgraded to core markets once certain performance thresholds are met, such as a critical amount in 30d volume or open interest.
2. **Supervised:** Markets that meet certain performance thresholds are put up for review, and the DAO (or a dedicated subDAO), follows a streamlined process to vote on an upgrade.

Notice that the risks posed by tampered oracles or poorly designed tokens are not necessarily reflected by market data, and may slip by if upgrades focus entirely on market data. This concern is exacerbated if sponsors engage in sophisticated wash-trading strategies to fake the performance of their markets, or provide large external incentives to attract traders and market makers.

If market upgrades are automated, then such malicious markets might quietly pass the upgrade requirements, and find themselves being advertised as core markets to traders. This would not only enable cross-margining and make the market part of the protocol-wide insurance fund, creating second-order contagion effects, but it would also increase activity in the market from more traders.

Instead, market upgrades might be triggered automatically, but go through a period of review. Throughout this period, community members may vote to veto the upgrade if a potential vulnerability is spotted. However, the default behavior in this process would be to upgrade markets, minimizing the friction of having to create a governance proposal to upgrade a popular permissionless market.

6.5 Summary

Permissionless listings are one of the most exciting innovations of dYdX Chain, and have been instrumental in the growth of several other DeFi protocols including Uniswap and Osmosis. With permissionless listings, dYdX v4 may scale from 32 initial markets to hundreds of new derivative markets with little to no governance overhead. This, in turn, could lead to a 10x increase in trading volume and fees.

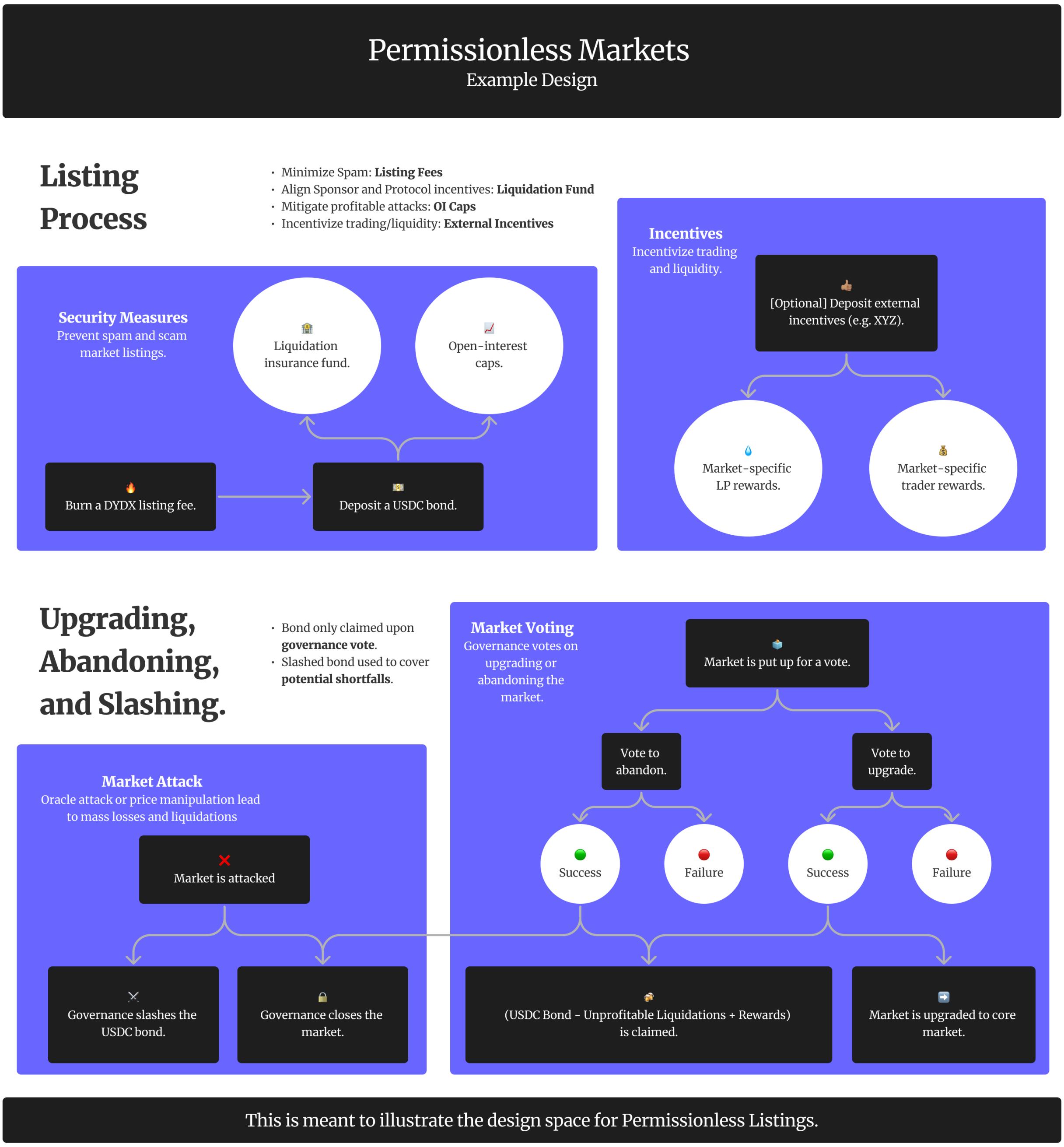
On the other hand, permissionless listings also have some undesirable implications for the protocol, including tampered market listings and the fragmentation of liquidity. Given the complex machinations of a cross-margined perpetuals exchange, we must consider:

- Will permissionless markets have isolated collateral?
- Will permissionless markets have isolated insurance funds?
- Will permissionless markets be eligible for Trader Rewards and Market Maker Rebates?
- Will permissionless markets have permissionless incentives?
- What preventative mechanisms will be established to prevent attacks on permissionless markets?

In Fig. 20, we provide an example for what the permissionless listings process could look like. We consider requiring a “bond” from the market Sponsor that governance may slash if the

[10] Popularity might be an aggregate metric based on 24h volume, 2% depth, total open interest, etc.

market is listed with a tampered oracle or token supply. This bond acts as a disincentive to list tampered markets due to the risk of slashing.



Permissionless Markets

Example Design

Listing Process

- Minimize Spam: **Listing Fees**
- Align Sponsor and Protocol incentives: **Liquidation Fund**
- Mitigate profitable attacks: **OI Caps**
- Incentivize trading/liquidity: **External Incentives**

Security Measures
Prevent spam and scam market listings.

Liquidation insurance fund.

Open-interest caps.

Burn a DYDX listing fee.

Deposit a USDC bond.

Incentives
Incentivize trading and liquidity.

[Optional] Deposit external incentives (e.g. XYZ).

Market-specific LP rewards.

Market-specific trader rewards.

Upgrading, Abandoning, and Slashing.

- Bond only claimed upon **governance vote**.
- Slashed bond used to cover **potential shortfalls**.

Market Attack
Oracle attack or price manipulation lead to mass losses and liquidations

Market is attacked

Governance slashes the USDC bond.

Governance closes the market.

Market Voting
Governance votes on upgrading or abandoning the market.

Market is put up for a vote.

Vote to abandon.

Vote to upgrade.

Success

Failure

Success

Failure

(USDC Bond - Unprofitable Liquidations + Rewards) is claimed.

Market is upgraded to core market.

This is meant to illustrate the design space for Permissionless Listings.

Figure 20: Permissionless Listings, example.

7

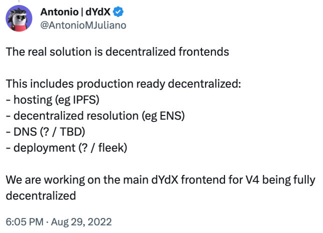
A Front End Incentives Program

With a larger focus on decentralization, new behaviors in the dYdX ecosystem might need to be incentivized, including the operation of front ends, and indexers. In this section, we describe a program to incentivize the deployment, maintenance, and decentralization of the dYdX Front End. We discuss why such a program might be necessary, and how it could be implemented with minimal surface area for value extraction from adversarial players. We further discuss how the community might leverage such a program to incentivize the deployment of Front Ends in strategic regions, with support for specific languages, or the addition of strategic features.

dYdX Trading has been developing three front ends for non-programmatic users, including one for the web, one for iOS, and one for Android. The team has recently open-sourced the code for operating these front ends, such that anyone can deploy and host the front end themselves. See the corresponding GitHub repository here. We asked Joseph Axisa (also known as @ImmutableLawyer on the dYdX forums) to explain why decentralizing the front end is at the core of a truly decentralized protocol:

> In a post on Substack (derived from a previous forum post of mine from the dYdX Forums) titled, 'Frontend Decentralisation' I discussed the importance of decentralising the frontend, the corresponding importance thereof and the factors that have to be taken into account so as to achieve a sufficient level of decentralisation at the frontend layer of a project. To put it simply, the frontend is the first point of access enabling users to interact with the underlying codebase. Thus this layer is an integral part of any project.
>
> In most cases, this pivotal piece of infrastructure is controlled in a centralised manner by one entity or a group of entities that back (directly or indirectly) the development of the project. This, naturally, gives rise to an increase in the project's centralisation, an increase in censorship risk and also introduces a single point of failure.

That is, decentralizing the front end is about eliminating single-points-of-failure from the dYdX protocol and making it more robust to a number of censorship risks. Given the current uncertain regulatory environment in the United States and other major jurisdictions, it is increasingly important to decentralize such a sensitive component of the protocol's stack.



Antonio | dYdX
@AntonioMJuliano

The real solution is decentralized frontends

This includes production ready decentralized:
- hosting (eg IPFS)
- decentralized resolution (eg ENS)
- DNS (? / TBD)
- deployment (? / fleek)

We are working on the main dYdX frontend for V4 being fully decentralized

6:05 PM · Aug 29, 2022

Figure 21: Tweet by Antonio Juliano, Founder and CEO of dYdX Trading, on decentralizing the front end.

7.1 The Challenge of Decentralization

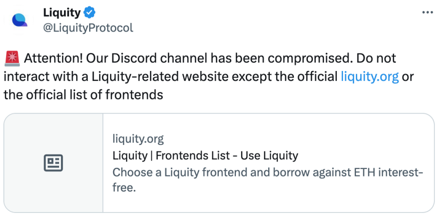
Decentralization, of course, does not come easily.

By decentralizing the front end, dYdX will now require a cohort of "front end operators" to deploy and maintain the dYdX v4 front end. This requires some financial resources to pay the necessary software developers, service the necessary server costs, and pay for any additional developer tools required to keep the site or application running. As we will discuss, the dYdX Operations Trust was funded, in part, to support the deployment of the dYdX v4 front end. However, no additional funds have been committed to incentivize the deployment and maintenance of front ends from other teams and in other jurisdictions. This section is devoted to the possibility that an insufficient number of front ends are deployed and maintained following the launch of dYdX Chain.

Aside from the possible lack of financial incentives, we also consider the user risks of decentralizing the front end. Under a decentralized front ends paradigm, the dYdX community might expect an increase in fraudulent or risky activity from malicious front ends, such as applying hidden fees, performing unnecessary data collection, or tricking users into signing fraudulent transactions.

"The FTC reports that crypto scams have increased by an incredible 900 percent since the start of the Pandemic."
— Department of Financial Regulation, State of Vermont

That is, decentralizing dYdX's front end expands the surface area of attack for malicious actors. Consider this novel attack performed by North Korea's Lazarus Group, where victims are directed to a clone of a well-known website and tricked into downloading malware targeting their private keys. It has been described in greater depth by the FBI and CISA here.



Liquity
@LiquityProtocol

🚨 Attention! Our Discord channel has been compromised. Do not interact with a Liquity-related website except the official liquity.org or the official list of frontends

liquity.org
Liquity | Frontends List - Use Liquity
Choose a Liquity frontend and borrow against ETH interest-free.

Figure 22: Tweet by @LiquityProtocol regarding a Discord scam targeting retail users with malicious front ends.

7.2 Introducing a Front End Incentives Program

With this in mind, we consider a potential incentives program that governance can use to influence the dYdX front end experience. In doing so, governance can encourage benign front end operators that abide by certain community-owned standards, and simultaneously direct retail users to those front ends and away from the malicious ones. We purport the following objectives for a Front End Incentives Program.

1. **Decentralization:** Incentivize the deployment of multiple separate front ends.
2. **Protection:** Foster a community-owned process for signaling "safe" front ends to retail users.
3. **Curation:** Incentivize front ends to abide by certain community-owned standards, and potentially incentivize new experiences.

Addressing objective 2 (protection) does not rely on any financial incentives, and we may establish and streamline governance processes to address it soon after the Genesis of dYdX Chain. This whitelisting process, as we will discuss, would be a community-owned version of the Liquity front ends list, shown in Fig. 22.

Objectives 1 and 3 rely on financial incentives from the community treasury, and as such may be deployed if and when governance deems it necessary. It may be appropriate to launch such an incentives program if we observe an insufficient amount of front ends being deployed, or if existing front ends are not providing an adequate experience for retail users - such as not providing appropriate risk disclaimers, or charging excessive additional fees.

7.3 Whitelisting: A dYdX Front End Registry

A key component of decentralizing the front end is mitigating the damage caused by scams and attacks on retail traders. As we see in Fig. 22, Liquity has an official website that links to a selection of Liquity front ends. Here, we propose how governance may host a similar registry of high-quality front ends that signals to users which front ends are safe, and whether they abide by certain minimum community-owned standards, discussed in the following Section.

We consider a whitelisting process that resembles Lido's EasyTrack program. Front end operators may submit proposals to be added to the front end registry, which will pass by default. Voters may then veto the submission if an applicant or application is found to be suspicious. By setting the default outcome of the proposal to be a success instead of a failure, we minimize governance overhead and expedite the process for onboarding new front ends. This might be further expedited by creating a subDAO to oversee dYdX's front ends, or adding this as a responsibility to an existing subDAO.

Existing dYdX subDAOs may maintain a separate website that hosts the registry, and the registry may be duplicated in a pinned forum post. We provide an example for a submission to add a new front end to the dYdX front end registry:

> “The responsibilities of a deployer will include:
>
> - Acquiring and owning web domain
> - Meeting deployment prerequisites: Installing Node.js 16 and npm locally Setting up web3.storage account Setting up Cloudflare account
> - Initial deployment of frontend Download of front end codebase and deployment script from dYdX Github Running deployment script to pin the files to IPFS and update the IPFS hash
> - Updating frontend Following the dYdX Github repos to get codebase updates Running the deployment script when new codebase updates are available to pin the updated files to IPFS and update the IPFS hash
> - Setup of ancillary accounts
>
> ”
>
> — v4 Deep Dive: Front End

[DRC] Add ABC.com to the Front Ends Registry

ABC.com is a front end hosted by ABC LLC in Lebanon and written in Arabic.

- <Company description>
- <Product Description>
- <Contact Information>
- <Product Screenshots>

Voting

- **Veto.** Veto this proposal.

Applications could be reviewed by governance or a dedicated subDAO. Applicants might be individual contributors, or larger aggregators such as DeFi Saver or Instadapp[11].

This whitelisting process also underpins the front end incentives program proposed in this report. Without a whitelisting process, adversarial users might be able to "farm" the incentives program. Furthermore, a lack of a whitelisting process would constrain the design of the incentive formula, precluding formulas that flatten the distribution of incentives, due to a problem known as "Sybil Resistance".

7.4 Community Standards

dYdX Trading has curated a successful user experience for v3 traders and we can expect that the front end for v4 will similarly provide a great experience for traders using a direct fork of their open source code. However, decentralizing the front end means front end operators can change, improve, or worsen the front end experience for their users. Over time, the dYdX community may choose to curate a set of minimum community standards for adequate front ends. These may include:

- Not charging excessive additional fees from users.
- Not collecting unnecessary browser data from users.
- Appropriate disclaimers for permissionless markets, markets with excessive price volatility, or markets with excessive external rewards. These disclaimers are similar to the disclaimers on Osmosis Zone, depicted in Fig. 17.

Using the whitelisting process discussed above, and the incentives program we will design in the following sections, governance may wield a small portion of the community treasury to encourage front end operators to abide by these standards and protect the retail experience.

7.5 Incentive Alignment and Opportunity Sizing

We now present an incentives program designed to incentivize front end operators proportionally to the value they contribute to the dYdX ecosystem.

The dYdX Operations Trust (DOT), has received funding to deploy and maintain the three front ends, as well as hire a 3rd party contractor to operate the v4 indexer. Read more about it in this forum discussion.

Consider an incentives program that offers front end operators a share of the fees generated by users trading on their platform. This creates sustainable value alignment between the front end operators and the protocol: operators are incentivized to increase trading fees by acquiring more users and increasing trading volume. Front end operators might:

- Integrate dYdX v4 with existing DEX aggregators, mobile apps, or payment services.
- Develop front ends in various different regions and languages, increasing accessibility and awareness, and reducing regulatory exposure to particular countries or blocs.
- Develop new and innovative features to complement the existing front end product.

We would like to formulate an incentives program where front end operators are remunerated in proportion to the value they create, which we can measure as a function of their volume generated. In sizing this program, we might first estimate how much trading volume these

[11] DeFi Saver and Instadapp are two of the largest front end providers for Liquity.

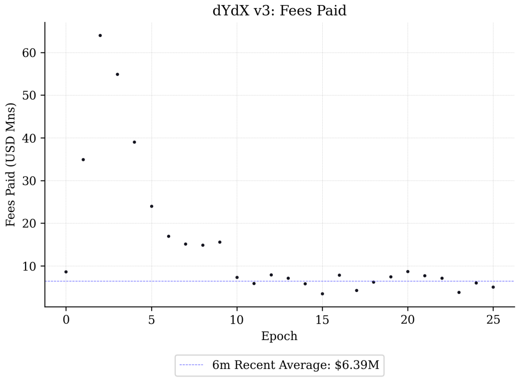


Figure 23: Fees paid by epoch in dYdX v3. The dotted line indicates the average fees paid between February and July of 2023.

front ends could realistically generate, and therefore, how much the dYdX community should be willing to pay them.

The gross amount paid in fees to the protocol is displayed in Fig. 23. From February to July of 2023, an average $6.79M USD has been paid in fees on dYdX v3 per epoch. Roughly 40% of trading fees paid to the protocol, meaning that approximately $2.7M USD is paid in fees through front ends, per epoch.

Table 3: Addressable Market

Fee-share Pct	DOT Mkt Share	Annual Addressable Mkt
1%	90%	$35K
5%	90%	$177K
10%	90%	$353K
1%	50%	$177K
5%	50%	$883K
10%	50%	$1,765K

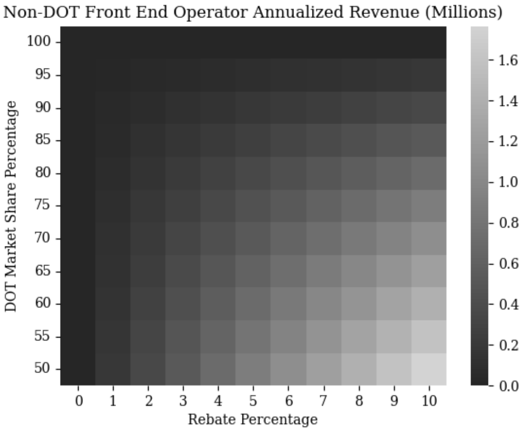


Figure 24: Fee revenue going to non-DOT operators as a function of the DOT's market share, and fee-share percentage. Assuming total fee revenue of $6.79M, with 40% originating from front ends.

Given the dYdX Operations Trust (DOT) will be supporting a front end, funded by the community treasury, it will likely take a large percentage of the front end market share. This significantly reduces the incentive for new teams to deploy, maintain, and innovate on dYdX's front end, if we rely exclusively on a revenue share system. Using recent per-epoch fees, we illustrate the potential size of a fee revenue share program in Fig. 24, with some example numbers in Table 3. Notice that, even if the DOT is removed from the incentives program entirely, it is likely that the distribution of rewards will still be "power-lawed".

We denote the percentage of front end fees being shared with front end operators as the *fee-share percentage*. Given that trading fees sustain the app chain's validators, and therefore are fundamental to the security assumptions for dYdX v4, the fee-share percentage must be kept relatively small. In Fig. 24, we consider some reasonable fee-share percentages, and assume that the DOT controls at least 50% of the front end market. For example, assuming the DOT takes 50% market share and the fee-share percentage is 1%, all other front end operators would split an annual $177K USD, a paltry incentive to decentralize the dYdX front end.

The DOT was awarded $360k USD to deploy and maintain all three front ends for dYdX v4.

7.6 Scoring Rules

So far we have assumed that incentives are disbursed *pro-rata* amongst front end operators. We may instead consider two alternative scoring rules for distributing incentives: a logarithmic scoring rule, defined in Eq. 8, and a square-root scoring rule, defined in Eq. 9. As shown in Fig. 25, both scoring rules flatten the distribution of rewards, increasing the incentives for new and smaller teams to participate in the incentives program and deploy new front ends.

Define the logarithmic scoring rule as

$$R_{i,\log} = \frac{\log(w_i + 1)}{\sum_j^N \log(w_j + 1)}, \tag{8}$$

where there are N participating front ends, w_i is the amount of trading fees routed through the ith front end, and $R_{i,\log}$ is their fraction of incentives (fees). Similarly, we define the square root scoring function as

$$R_{i,\sqrt{}} = \frac{\sqrt{w_i}}{\sum_j^N \sqrt{w_j}}, \tag{9}$$

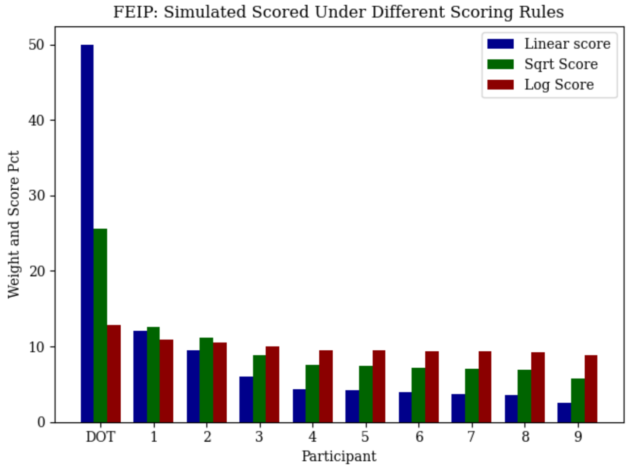


Figure 25: Simulated scores for the front end incentives under different scoring regimes, assuming the DOT takes 50% market share.

From Fig. 25 it is clear that either scoring rule produces a flatter rewards distribution than a naive *pro-rata* distribution. This significantly increases the incentives for smaller teams to deploy new front ends, and decreases the risk they are unable to service their costs if their front end does not get enough traction. However, the logarithmic scoring rule produces an almost entirely flat curve, largely removing any meritocracy in the incentives program. This is not desirable either: some degree of meritocracy encourages participants to continuously innovate on their product and acquire more customers.

We may choose to further parameterize our scoring rules to achieve some optimal degree of "flattness" in the rewards distribution. For example, we may use a cubed root instead of a square root to further flatten the distribution under a root scoring rule, or we may scale the argument of the log by a constant k. Either parameterization could be used to control this flattening process, but introduces complexity in designing the incentives program. To keep the incentives program simple, and remove any operational overhead in designing and maintaining the program, we consider moving forward with the square-root scoring rule. We revise the addressable market size from Table 3 in Table 4 using our newly proposed scoring function. Notice how the incentives, particularly when the DOT takes most of the market share, are significantly higher under a square root scoring function than under the *pro-rata* distribution, by on the order of 5x.

Table 4: Addressable Market, Sqrt Scoring Rule

Fee-share Pct	DOT Mkt Share	Annual Addressable Mkt
1%	90%	$167k
5%	90%	$837k
10%	90%	$1,669k
1%	50%	$258k
5%	50%	$1,287k
10%	50%	$2,573k

Any non-linear scoring rule would require the incentives to be pooled for some period of time while scores are calculated and then disbursed to participants. A possible implementation of this is to re-use the design of dYdX v3's rewards programs, which rewarded participants in ethDYDX at the end of each epoch. This might entail pooling the rewards for a certain period of time, perhaps a block, perhaps an epoch. The protocol would then track the percentage of trading fees originating from each front end, compute their score, and distribute the proceeds at the end of the measurement period.

Notice that, under a non-linear scoring rule, front end operators are incentivized to Sybil-attack the incentives program. Instead of building one front end and acquiring users to trade through this front end, operators would be encouraged to create many front ends, and leverage the non-linearity of the scoring rule to get more rewards, without having to contribute more in trading fees to the protocol. Furthermore, consider programmatic traders who trade via API instead of front ends, such as market makers or arbitrageurs, that push significant volume on dYdX chain. Under any front end incentives program that does not require a whitelisting process and rewards front ends proportional to their trading activity, these programmatic traders are incentivized to spoof a front end connection to be eligible for rewards. The whitelisting process described in a previous Section eliminates these concerns.

> “dYdX Trading identified 80 Ethereum addresses (listed below) that conducted clear wash trading during Epoch 0 and removed them from receiving Trading Rewards for Epoch 0.”
>
> — Wash Trading - Epoch 0

7.7 DYDX Rewards or Fee Sharing?

Although governance will be able to control “fee-sharing” on dYdX Chain (for example, using the Community Tax discussed in Section 4), there are several reasons the community might want to avoid enabling this feature shortly after the Genesis of dYdX Chain, particularly in ensuring the security of the chain’s consensus mechanism. Instead, we consider using DYDX rewards to fund this incentives program, until governance is comfortable enabling a fee share across the dYdX ecosystem.

If governance were to choose to implement this program using DYDX rewards, we may use the discussions from the previous sections to size this program. First, we would have to modify our square-root scoring rule such that governance does not “overspend” on these incentives. We take inspiration from the v4 Trader Rewards formula, discussed in Section 5, which prevents traders from earning more in rewards than they pay in fees. We might similarly set:

$$A = \min\left(\frac{C \cdot S}{p}, T\right) \tag{10}$$

where A is the amount in rewards that will be disbursed, T is the maximum amount in rewards that governance is willing to pay, C is the maximum percentage of trading fees that governance is willing to pay, S is the sum of trading fees routed from participating front ends, and p is the price of DYDX. Intuitively, this formula ensures that governance will never overpay for front end incentives: it will always pay at most C% of the fees routed from that front end. As this functionality will already have been developed by dYdX Trading, it signfiicantly streamlines the implementation of this program. The rewards, A, may then be disbursed according to the square-root scoring rule introduced in Eq. 9.

> “Decentralized ecosystems, if properly structured, can use tokens to incentivize participants to contribute value to the ecosystem and correspondingly distribute that value more equitably among system stakeholders according to their contributions. To achieve this, web3 systems need to vest meaningful power, control, and ownership with system stakeholders (via airdrops, other token distributions, decentralized governance, etc.). As a consequence, the value of the ecosystem as a whole accrues to a broader array of participants rather than one central entity and its shareholders.
> The ongoing balancing of incentives among the stakeholders-developers, contributors, and consumers-can then drive further contributions of value to the overall system, to the benefit of all.”
>
> — *Factors of decentralization of web3 protocols* by Miles Jennings, Stephen Wink, Adam Zuckerman

7.8 Summary

dYdX v4 is fundamentally about decentralizing the various components of the protocol, from the orderbook to the front end. In this Section, we have outlined how and why the DAO might implement a whitelisting and curation process for a Front Ends Registry. This Registry signals to retail users which front ends abide by certain community-owned standards and are unlikely to commit any frauds. We then discuss how and why an incentives program might be appropriate to accelerate the decentralization of the dYdX front end, and perhaps contribute to the innovation and improvement of the user experience. We observed that the addressable market for incentivizing front end operators using a fee share is small, particularly given the large market share the dYdX Operations Trust will likely take. We proposed a square root scoring rule for incentivizing small front end operators to maintain new front ends, encouraging the development of front ends in different regions, languages, and perhaps with different functionalities. Finally, we discussed how and why this program might be funded with DYDX rewards instead of a direct trading fee share.

8

Governance in the Cosmos

The final section of this report focuses on the governance process itself. dYdX Chain governance controls several parameters and processes on dYdX Chain via governance proposals. These proposals may upgrade the Chain's validator software, update parameters, spend the community's resources, and more. In this Section, we briefly describe the governance process on dYdX Chain, including its key parameters. We then overview dYdX's existing governance structures, including the dYdX Grants Program and the dYdX Operations Trust. Finally, we discuss the success of the endorsed delegate program on dYdX v3 and how it may be implemented on dYdX Chain with a less-known CosmosSDK module called `x/authz`.

Governance on Cosmos chains has a number of differences and similarities with governance on Ethereum-based protocols. One of the main differences is that votes on Cosmos chains are often cast by the chain's validators. This has been a point of contention for many Cosmos chains, with some arguing that validators should largely abstain from governance and focus on doing what they do best: validating the chain. Governance should instead be conducted by community members with deep domain specific knowledge of the chain, its ecosystem, and priorities. Delegating votes to these community members has become a popular practice amongst many Ethereum-based protocols including dYdX.

However, enabling delegation to non-validators poses a technical challenge on Cosmos, which we will discuss. For a great introduction to Cosmos and Cosmos governance purpose-written for dYdX, refer to this post by RoboMcGobo, a dYdX and Osmosis community member and grantor for the dYdX Grants program. For a more detailed overview of the dYdX Chain governance process, see this comprehensive report from Flipside Crypto's governance team!

8.1 The Governance Process

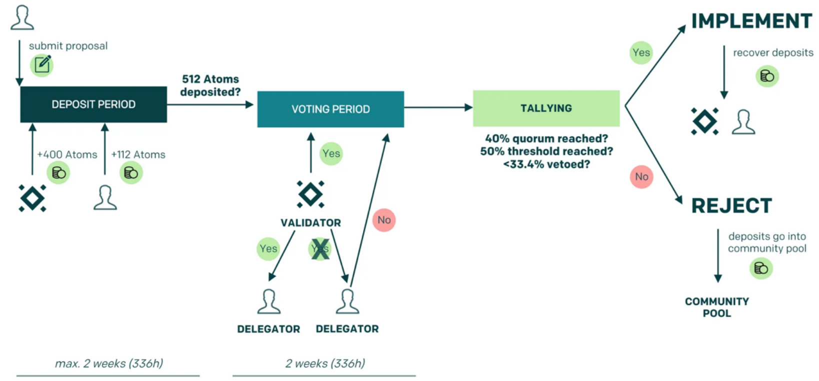


Figure 26: The Cosmos governance process, taken from this blog post by Felix Lutsch, Chorus One.

The CosmosSDK module `x/gov` underpins the governance process of most Cosmos blockchains, including dYdX Chain. To understand dYdX Chain governance, one must first have a basic understanding of the `x/gov` process.

On dYdX Chain any user can submit a proposal along with an initial deposit. The minimum initial deposit required to submit a proposal is defined by the `min_initial_deposit_ratio` parameter, which can be set to 0. By raising the minimum initial deposit, governance could throttle the quantity of submissions. This might be appropriate, for example, if the governance process is being overwhelmed by numerous frivolous proposals.

Following the initial proposal, other token holders might contribute to a proposals initial deposit until a `min_deposit` is reached, currently set at 10*k* DYDX as of the latest testnet, which is subject to change. Again, governance may choose to raise or lower this minimum deposit depending on how difficult it is to reach it.

Once a proposal has reached the minimum deposit, it enters a voting period lasting 7 days. Validators and stakers may vote on a proposal with their staked DYDX. A staker will inherit the vote of their validator unless they choose to manually override it. As it stands, stakers cannot choose to delegate their voting power to any user other than a validator.

Once the voting period ends, the module will check whether at least 33.4% of staked tokens have voted, known as quorum. If quorum was met, a proposal is implemented as long as more than 50% of votes were in favor of the proposal, and less than 33.4% of votes vetoed the proposal. All these thresholds are parameters that governance may modify through parameter change proposals as well.

The governance process for the Cosmos Hub is depicted in Fig. 26, taken from a blog post by Felix Lutsch as Chorus One. Although some governance parameters for the Cosmos Hub are different than those for dYdX Chain, the process is still the same.

8.1.1 Relevant Governance Parameters

Following the methodology in Appendix B, we reproduce the dYdX Chain testnet governance parameters in Table 5. A key responsibility for dYdX Chain governance will be to the monitor governance process and ensure a fair, transparent process for surfacing important proposals, while minimizing clutter and governance overhead. Part of that responsibility involves tuning and managing these governance parameters, if necessary.

Table 5: `x/gov` Parameters

Name	Value
burn_proposal_deposit_prevote	False
burn_vote_quorum	False
burn_vote_veto	True
max_deposit_period	86400s
min_deposit	1000000
min_initial_deposit_ratio	0
quorum	0.33400
threshold	0.50000
veto_threshold	0.33400
voting_period	86400s

8.2 subDAOs

Throughout this report we have discussed the several responsibilities of dYdX governance, or the DAO, in operating dYdX Chain. This includes proposals to spend DYDX on various initiatives, funding grants, slashing misbehaving validators, tuning risk parameters, minimizing fraud in front ends, and much more. Of course, each of these responsibilities requires sophisticated domain-specific knowledge to be adjudicated appropriately. This creates a problem: the DAO has too much responsibility spread amongst individuals who might have competencies in some areas, but not in others. To make the DAO more efficient, we would ideally focus specific decisions on smaller groups of community members and service providers that are particularly knowledgeable about those kinds of decisions! subDAOs, or working groups, are exactly that; subsets of the DAO that have domain specific knowledge that accelerates and improves decision making under a specified mandate.

> “In conclusion, it is claimed that the effective Organization will favor some sort of configuration—some type of a logically consistent clustering of its elements—as it searches for harmony in its internal processes and consonance with its environment.”
> — *Structure in 5's: A Synthesis of the Research on Organization Design* by Henry Mintzberg

dYdX has two primary subDAOs: the Operations subDAO, which is led by the dYdX Operations Trust, and dYdX Grants.Both subDAOs have clear and distinct mandates to grow and operate the dYdX ecosystem, including and especially its transition to dYdX v4. The grants program primarily manages dYdX's grants budget, vetting and funding teams that contribute to the dYdX ecosystem, as well as providing assistance to grants recipients to accelerate project completion. To date, the dYdX Grants program has facilitated over 120 grants and over $4M USD of funding across a wide variety of topics.

> “The dYdX Operations subDAO serves the dYdX community, with the mandate to establish a team to set up and operate infrastructure for dYdX v4, the community, and help grow the dYdX ecosystem.”
> — dYdX Ops subDAO

The purpose of the Ops subDAO is two-fold, part technical and part governance. The technical mandate for the Ops subDAO is to maintain key infrastructure for dYdX Chain, including the chain's three front ends, as well as supporting an external team to maintain one of the chain's indexers. In terms of governance, the Ops subDAO is tasked with helping grow dYdX's ecosystem, including establishing new relevant subDAOs for dYdX Chain. But what subDAOs might be most relevant following the launch of dYdX Chain?

8.2.1 New subDAOs

Part of the Ops subDAO's mandate was developing the subDAO playbook. Let's take a page of the subDAO playbook to answer the question: when is a subDAO needed?

> When deciding if a subDAO is needed, we recommend that the Community ask itself: is there a job to be done/information to be found that requires specialization and rapid decision-making?
>
> If the answer is "yes," a subDAO could be the answer.

The dYdX DAO Playbook

A guide to building the future of dYdX governance

Figure 27: Screenshot of the Ops subDAO playbook.

Throughout this report, we have touched upon a few key responsibilities for dYdX governance that might be facilitated with either subDAOs or service providers. These have included: risk management of market and liquidation parameters, managing incentives program parameters and expenses, and keeping validators properly incentivized (including reviewing MEV activity). We discuss these and other keys functions within dYdX in Table 6[12]

We test each of these 5 subDAOs against the litmus test from the subDAO playbook in Table 6. Notice that many responsibilities overlap between subDAOs, for example: should an Incentives subDAO or a validator management subDAO handle trading fees? In practice, a small subset of these potential subDAOs, such as the Risk subDAO and the Incentives subDAO, could absorb all the high priority responsibilities. Treasury management, for example, could have the operational role of conducting transactions absorbed by the Ops subDAO, whereas the accounting functionality could be offloaded to a service provider or grantee. Monitoring MEV might fall under the mandate of Risk, while ensuring proper validator and market maker incentives might be a task for the Incentives subDAO. Over time, dYdX will identify the minimum viable set of subDAOs to operate efficiently, avoiding the bureaucracy of creating too many overlapping or unnecessary subDAOs, but ensuring key functions can be executed efficiently. If one subDAO has too much on its place, a new subDAO might be formed to partition the original mandate.

Table 6: dYdX subDAOs - A Litmus Test

subDAO	Goal	Requires Domain-Specific Knowledge	What Knowledge?	Requires Speedy Decision Making	When?
Risk subDAO	Optimize market risk parameters and prevent unnecessary losses from [missed] liquidations. Maybe: handle asset listings.	Yes	Market and liquidity risk modeling.	Yes	During periods of high market volatility and risk.
Incentives subDAO	Optimize the protocol's incentives, including Trading Rewards, maker and taker fees/rebates, launch incentives, etc.	Yes	Some behavioral economics; keen understanding of pricing and elasticity.	Unlikely	Decisions with respect to rewards or trading fees are unlikely to require speedy decision making.
Validator management subDAO	Monitor validator behavior and ensure proper validator incentives	Yes	Knowledge of MEV and the validator business model.	Yes	Catching and punishing MEV quickly could save users significant capital.
Treasury management subDAO	Conduct transactions from and to community-owned accounts on dYdX Chain, and perform accounting on treasuries.	Some	Some knowledge of transactions on dYdX Chain, and accounting.	Yes	Urgent proposals to consume treasury resources, such as providing emergency capital to the liquidation fund.
Business Development subDAO	Manage relationships and service requests from validators, market makers, and other key ecosystem players.	Some	Ideally, members would have deep personal networks with relevant players, and are able to both understand their problems and negotiate reasonable solutions.	Yes	Validators and market makers might have several urgent requests and concerns, many of these might be technical.

[12] Two of these subDAOs are inspired by a post from Kagan at Fox Labs (now Cypher Labs), a dYdX community member.

8.3 Endorsed Delegates

The subDAO debate revolves around focusing the right people on the highest priority problems for dYdX, and making it easy for them to operate efficiently. A related component of this process is endorsed delegation. Endorsed delegation allows token holders (or stakers) to delegate their voting power to any user of their choice, instead of exclusively delegating to the chain's validators. In theory, this "representative democracy" approach providers token holders with the peace of mind that their tokens are being in their best interest, as each token holder can choose an endorsed delegate that closely aligns with their values and beliefs.

On the surface level, it appears that delegating to validators achieves the same effect: one must simply identify a validator that aligns with one's interests as a staker and trader on dYdX Chain. However, to understand why endorsed delegates are an important debate for many existing Cosmos chains, we must understand the potential pitfalls of letting validators vote on behalf of stakers:

- Validators are experts at maintaining high-fidelity systems. They are not necessarily experts on protocol governance, trading incentives, market risk, and the many other aspects of operating a decentralized exchange[13].
- Validators have little incentive to participate in governance outside of their reputation. Although some stakers might decide who to stake to based on governance participation, many others simply choose the most profitable validator with the lowest commission rate. Hearkening back to the previous point, a validator's primary competence and primary incentive is being a good system operator.
- Validators might have conflicts of interest with other chains. For example, if validator A supports chain *xyz.com*, then they might be incentivized to vote in favor of listing XYZ token on dYdX, regardless of the potential risks associated with XYZ token.

The endorsed delegate versus validator governance model debate is really a manifestation of the Principal-Agent problem. Ideally, delegators would delegate their voting power to the delegate that best represents their interests. By enabling more than just validators to receive delegated voting power, we would open up the "delegation marketplace" to any user. This, in turn, creates a competitive dynamic for delegates to research and identify relevant interest groups that they can represent within the dYdX governance system, and gives delegators more options from which to choose. A larger more competitive marketplace would, some argue, create greater alignment between delegates and delegators. Simultaneously, validators would no longer be expected to participate in the governance process (although they could, and many might choose to), freeing them to focus on their actual business: running a profitable validator node.

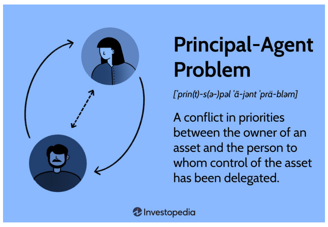

Principal-Agent Problem
['prin(t)-s(ə-)pəl 'ā-jənt 'prä-bləm]
A conflict in priorities between the owner of an asset and the person to whom control of the asset has been delegated.
Investopedia

Figure 28: The Principal-Agent problem, from investopedia.

8.3.1 Endorsed Delegates via `x/authz`

As it stands, endorsed delegation is not implemented on dYdX Chain. This is largely due to a technical challenge of separating the economic value of DYDX tokens with their voting power. That is, a staked DYDX token is escrowed with the validator and can be slashed as well as accrue rewards. This is its economic value. Simultaneously, that same DYDX token holds governance rights, and those governance are delegated to a separate account.

There is one Cosmos SDK module that enables this kind of separation, the `x/authz` module. `x/authz` enables one account to grant arbitrary privileges to another account. Specifically, the module empowers a user (the grantor) to grant another user (the grantee) with the right to submit `Msgs` on the grantor's behalf. A `Msg` is a primitive object in any Cosmos chain that defines how the chain transitions from one state to another (recall that a blockchain is really just a machine that computes state transitions). One such `Msg` might be a `VoteMsg`, meaning that a user has cast a vote on a particular proposal. Through `x/authz`, a user might allow another user to submit `VoteMsgs` on their behalf, thus enabling the process of endorsed delegation.

Of course, this is a slight oversimplification. For example, there is no canonical user interface for interacting with the `x/authz` module on any Cosmos chain, although there are some primers and tools for doing so like this tool from the Resolute team. Furthermore, dYdX Chain will not be implementing the `x/authz` module at launch, so it must be added and configured at some later point in time.

Generally, the authors are excited to see `x/authz` or other superior solutions implemented on dYdX Chain, so that the true underlying market forces of governance can work their magic.

[13] Some validators, of course, do support robust governance research and operations within their businesses. The governance-competent validators could retain their delegated voting power by also being endorsed delegates on dYdX.

Appendix

A

Authors, Contributors, and Acknowledgements

This report was prepared by Thomas and Max at Xenophon Labs. We would like to thank the several community members that have offered invaluable feedback on the contents of this report, some of which took the time to contribute with their own thoughts. We list them below in alphabetical order.

- Carl Bergman (@cbergz) - dYdX community member and DGP grantor.
- @0xCchan - dYdX community member and grantee
- @JohnnyWyles - Osmosis Labs, Community Liason
- Joseph Axisa (@ImmutableLawyer) - dYdX community member, DOT enforcer
- @RoboMcGobo - dYdX community member, DGP grantor

B

dYdX Chain: Genesis

A key component of any Cosmos blockchain is the Genesis state. The Genesis state is the initial configuration of the blockchain's parameters, initial accounts, token allocations, etc.. In this appendix, we query the `genesis.json` file for dYdX v4's third testnet, and paste relevant chunks of that file for reference, such as initial markets and rewards parameters.

B.1 Querying `genesis.json`

The `genesis.json` file contains a chain's initial state. For dYdX Chain, this entails the chain's initial markets, rewards parameters, staking parameters, treasury accounts, and many other things.

To query the `genesis.json` file, run the following command in the terminal of your choice:

```
curl https://dydx-testnet-archive.allthatnode.com:26657 --header "Content-Type:␣application/
      json" --request GET --data '{"jsonrpc":"2.0",␣"id":1,␣"method":"genesis"}' > genesis.
      json
```

This will query the Genesis state for dYdX Chain's testnet and save it to a local `genesis.json` file. To query for mainnet, choose a Tendermint RPC provider (such as AllThatNode, a dYdX Chain validator), and find the appropriate endpoint.

B.2 Examples

Here are some examples relevant to items discussed throughout this report.

B.2.1 Perpetual Markets

The chain's perpetuals markets available at Genesis include:

```
['BTC-USD',
 'ETH-USD',
 'LINK-USD',
 'MATIC-USD',
 'CRV-USD',
 'SOL-USD',
 'ADA-USD',
 'AVAX-USD',
 'FIL-USD',
 'LTC-USD',
 'DOGE-USD',
 'ATOM-USD',
 'DOT-USD',
 'UNI-USD',
 'BCH-USD',
 'TRX-USD',
 'NEAR-USD',
 'MKR-USD',
 'XLM-USD',
 'ETC-USD',
 'COMP-USD',
 'WLD-USD',
 'APE-USD',
 'APT-USD',
 'ARB-USD',
 'BLUR-USD',
 'LDO-USD',
 'OP-USD',
 'PEPE-USD',
 'SEI-USD',
 'SHIB-USD',
 'SUI-USD',
 'XRP-USD']
```

B.3 Rewards parameters

The testnet dYdX Chain defines the rewards token as the testnet token `dv4tnt`, we can see the rewards parameters in the Genesis file:

```
                 'rewards': {'params': {'denom': 'dv4tnt',
                   'denom_exponent': -6,
                   'fee_multiplier_ppm': 990000,
                   'market_id': 11,
                   'treasury_account': 'rewards_treasury'}},
```

Notice that the `fee_multiplier_ppm` is the C parameter discussed in Section 5, and is equal to 0.99, or 990000 parts-per-million.

C
Wash Trading Profitability Analysis

We consider whether wash trading is profitable from the perspective of a user that both trades and stakes on dYdX Chain. We find that a wash trading strategy offers relatively low returns (<20%) if there is sufficient value staked on the chain (we used $200M in our example), given C=0.99 and the current v3 Trading Rewards Emissions ($3.2M USD per epoch). Conversely, if emissions are too high relative to total chain stake, then returns may be very high (e.g. 75% with $50M staked). We find that, by introducing a minor reduction to the C parameter, the dYdX protocol may effectively eliminate wash trading from the trading rewards module.

We derive the conditions necessary for wash trading to be profitable as a function of the module's C parameter and the emissions, E, it receives. We assume there is only one user wash trading on the chain, creating a conservative bound on their maximum profits. Of course, under an N player game, each player competes everyone else's profits away. We base our analysis on $C = 0.99$, the C value discussed on a recent announcement by dYdX Trading[14].

C.1 Payoffs

Trading fees on Cosmos are distributed roughly *pro-rata* amongst all validators every block[15]. A user staking to a validator will therefore receive fees proportional to their staked DYDX.

Suppose a user is staking with a validator and this validator is part of the active validator set. Further, suppose the commission rate the validator charges is c. The user pays f in fees and receives up to $C \cdot f$ in rewards (WLOG, assume rewards are in USD). We know that the user's staking rewards will be a function of their stake and their validator's stake relative to the chain's total staked amount:

$$\begin{aligned}\text{Staking Rewards} :=& \\ &= \frac{\text{Validator Stake}}{\text{Chain Stake}} \cdot \frac{\text{User Stake}}{\text{Validator Stake}} \cdot (1-c) \cdot f \\ &= \frac{\text{User Stake}}{\text{Chain Stake}} \cdot (1-c) \cdot f\end{aligned}$$

Denote the user's stake as s and the total stake as T, then their payoff is expressed as:

$$\text{Payoff} := \underbrace{\underbrace{C \cdot f}_{\text{Trading Rewards}} + \underbrace{\frac{s}{T} \cdot (1-c) \cdot f}_{\text{Staking Rewards}}}_{\text{Revenue}} - \underbrace{f}_{\text{Cost}} \tag{11}$$

Notice that for a user maximizing their wash trading profits, the choice for which validator they pick is based exclusively on (1) is this validator part of the active set? and (2) what is their commission rate?

For now, let's suppose that the emissions to the trading module are infinite, then the user will want to wash trade an infinite amount if the following is true:

$$C + \frac{s}{T} \cdot (1-c) > 1 \tag{12}$$

[14] Note that the C parameter will be set to 0 at Genesis.

[15] Refer to this documentation for an explanation as to why.

C.1.1 A Strict Condition to Prevent Wash Trading

Let $s_{\max}$ be the proportion of the chain's stake controlled by the user with the largest staked balance, affectionately named the whale. Further, let $c_{\min}$ be the lowest commission rate offered by an active validator. Then to ensure wash trading is not profitable for the whale, we must set:

$$C < 1 - s_{\max}(1 - c_{\min}) \tag{13}$$

In doing so, we ensure that the maximum discount paid to the whale can never make wash trading profitable. Unfortunately, we cannot accurately measure $s_{\max}$ since a user can split their stake among many accounts. We must then rely on estimates for how much of the chain's stake might reasonably be controlled by a malicious agent.

Expected $s_{\max}$	Maximum C
1%	99.5%
2%	98.1%
5%	95.25%
10%	90.05 %
20%	81%

Table 7: Maximum C parameter to prevent wash trading given expected $s_{\max}$.

On Table 7, we demonstrate the maximum C we may set while keeping wash trading unprofitable, based on an expected $s_{\max}$.

As it stands, the Genesis setting of $C = 0.99$ allows any user with more than $\approx$ 1% of the chain's stake to profitably wash trade under certain conditions. Of course, the larger their share of the chain's stake, the more profitable they are. If the dYdX community wants to eradicate wash trading from dYdX Chain, then it may choose to enforce a stricter condition. For example, by setting $C = 0.95$, a user must command at least $\approx$ 5% of the chain's stake to profitably wash trading. This significantly increases the initial investment required to profit from trading rewards.

C.2 Estimating Profits

To understand whether wash trading could incur meaningful losses to the dYdX protocol we derive the exact profit function for a single wash trader on dYdX Chain. This trader's profits are necessarily losses to the trading rewards program.

By deriving optimal fees we can convince ourselves that a profitable wash trader could profit off the fees they pay, even in blocks that have relatively high volume.

First, we return to the wash trader's payoff function and substitute C for $\min\left(\frac{E}{F_0+f}, C\right)$, where F_0 is the amount of "organic" fees being paid by other users. This reflects the fact that the emissions to trading rewards module, E, are finite, so the "effective discount" earned by the user can be lower than C:

$$\text{Payoff} := f \cdot \left(\min\left(\frac{E}{F_0 + f}, C\right) + s_{\max} \cdot (1 - c) - 1\right) \tag{14}$$

We can derive the optimal fees paid by first observing the shape of the payoff curve, shown in Fig 29:

An "Empty" block is a block where $F_0 \cdot C < E$, whereas a "Full" block has $F_0 \cdot C \geq E$. The "Constrained" payoff involves taking the $\min\left(\frac{E}{F_0+f}, C\right)$, whereas the "Unconstrained" problem ignores the maximum discount and simply pays $\frac{E}{F_0+f}$ in rewards. Notice that this distinction allows us to see what the optimal strategy is for the user:

1. **Empty block:** The maximum discount constraint enforces a linear payoff until $\frac{E}{F_0+f} < C$, at which point the payoff slopes down. Clearly, the user would pay fees until $\frac{E}{F_0+f} = C$ so they maximize their fees at $f = \frac{E}{C} - F_0$.

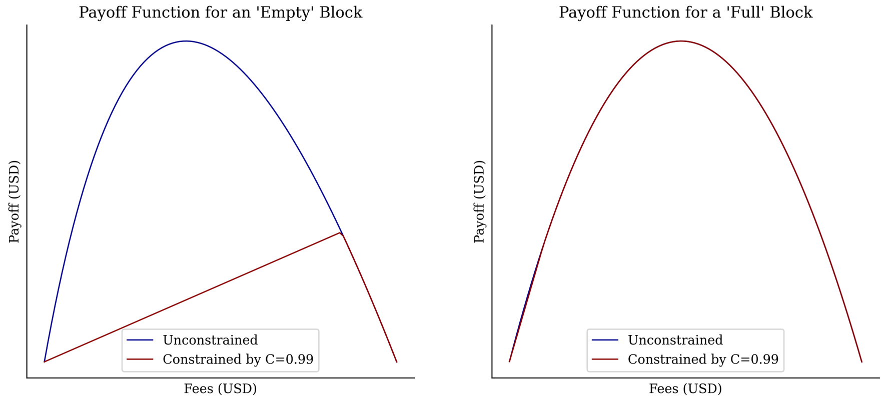


Figure 29: User payoffs for when F_0 is low (an empty block) and when F_0 is high (a full block).

2. **Full block:** Here the effective discount will be less than the maximum discount regardless of what the user pays in fees, they therefore want to maximize

$$f \cdot \left(\frac{E}{F_0 + f} + s_{\max} \cdot (1 - c) - 1 \right), \tag{15}$$

which we do with some simple calculus:

$$\begin{aligned} \frac{d\text{ Payoff}}{df} &= \left(\frac{E}{F_0 + f} + s_{\max} \cdot (1 - c) - 1 \right) - f \cdot \frac{E}{(F_0 + f)^2} \\ &= \frac{E \cdot F_0}{(F_0 + f)^2} + s_{\max} \cdot (1 - c) - 1. \end{aligned}$$

Set this to 0 and solve:

$$1 - s_{\max} \cdot (1 - c) = \frac{E \cdot F_0}{(F_0 + f)^2}, \tag{16}$$

so

$$f_{\text{opt}} = \sqrt{\frac{E \cdot F_0}{1 - s_{\max} \cdot (1 - c)}} - F_0. \tag{17}$$

What we find in deriving optimal fees is the following:

$$f_{\text{opt}} = \begin{cases} \max\left(\sqrt{\frac{E \cdot F_0}{1 - s_{\max} \cdot (1-c)}} - F_0, \frac{E}{C} - F_0, 0 \right) & , C > 1 - s_{\max} \cdot (1 - c) \\ 0 & , \text{otherwise} \end{cases} \tag{18}$$

With this equation, we can (1) better understand the behavior of a wash trader in different conditions (i.e. low volume and high volume blocks), and (2) estimate the losses to the protocol. This may help us determine whether wash trading is a legitimate concern.

Parameter	Value
Emissions (E)	3,164,384 USD
Max Discount (C)	99%
Min Commission (c)	5%

Table 8: Presumed parameters for Trading Rewards

C.2.1 Estimating Losses

Equipped with the optimal fee equation we can determine the wash trader's maximal payoff, and therefore the community's loss:

$$\text{Protocol Losses} := f_{\text{opt}} \cdot \left(\min\left(\frac{E}{F_0 + f_{\text{opt}}}, C \right) + s_{\max} \cdot (1 - c_{\min}) - 1 \right). \tag{19}$$

We can also compute the wash trader's returns on invested capital (inclusive of fees):

$$\text{Returns} := \frac{f_{\text{opt}} \cdot \left(\min\left(\frac{E}{F_0 + f_{\text{opt}}}, C \right) + s \cdot (1 - c) - 1 \right) \cdot 13}{s \cdot T}, \tag{20}$$

where T is the dollar value of the total chain stake. There are many variables here. Let's build some intuition for protocol losses using some reasonable values. Let's assume that the emissions are equivalent to v3 emissions, as in Table 8.

From these parameters and equations, we can compute a wash trader's annualized returns using current (v3) trading rewards emissions and the Genesis C parameter of 99%. We loop through possible $s_{\max} \in [0, 1]$, derive their f_{opt}, and then calculate the trader's returns. We graph the highest possible returns for a wash trader as a function the chain's total stake in Fig. 30. Notice that for reasonable total chain stakes like \$200M USD, the highest possible returns for a wash trader are still pretty low given the risk and intricacy of this trade at around 20%.

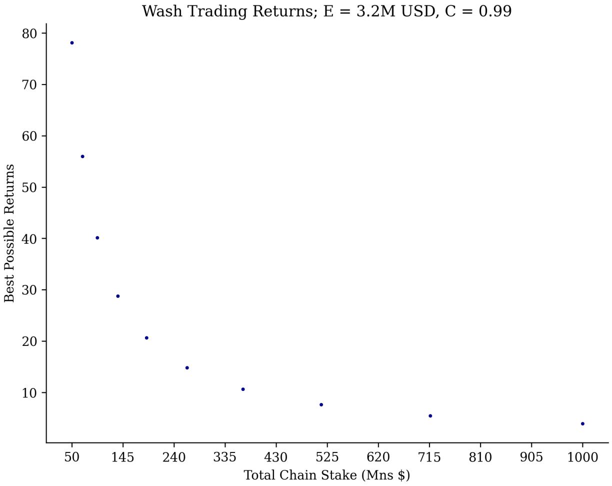


Figure 30: Highest possible annualized returns for a wash trader assuming ≈ \$3.2M USD in trading rewards emitted every 28 days, or approximately \$40M annualized, and $C = 0.99$, as a function of total chain stake.

In Fig. 31, we depict how the wash trader's profitability is highly sensitive to the organic flow of fees over the measurement period, as well as their share of the chain's total stake.

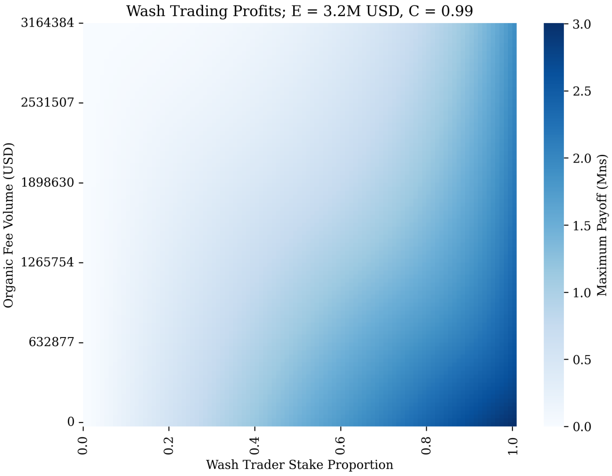


Figure 31: Heatmap of wash trader payoff (profits) from wash trading as a function of organic fee volume and their share of total stake.

C.3 Conclusion

In conclusion, we can form conservative bounds on wash trader profitability, and therefore protocol losses, using the methodology outlined in this Section. Once we have an expectation on the maximum share of dYdX Chain's total stake that an adversarial agent might command, $s_{\max}$, we may then set C to entirely prevent them from profitably wash trading. This, of course, is a function of the total dollar value staked to the chain: if \$1B USD is staked on the chain, acquiring 1% of this stake is much costlier than if \$1M USD is staked.

Once the chain launches and there is data on the dollar value of the chain's stake, as well as its general distribution, we might form reasonable expectations for $s_{\max}$. Based on these expectations we may: (a) simulate the value a wash trader could siphon out of the trading rewards program, and (b) adjust C to prevent them from profitably wash trading.

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