dYdX V4 - Liquidity Driven Permissionless Market Listings

Abstract

The impending launch of dYdX's permissionless asset listing is poised to transform the decentralized financial ecosystem. This cutting-edge feature paves the way for foundations and global cryptocurrency traders to expediently enlist their assets on the dYdX platform. We aim to give dYdX users the freedom they enjoy when listing any token pair on Automated Market Makers (AMMs) like Uniswap and pioneer the permissionless listings feature in perpetual markets. While this functionality can catalyze the platform's expansion, it concurrently gives rise to notable perils. Foremost among these concerns is the increased susceptibility to

malevolent attacks, which jeopardize the quality of user engagement and could engender instability in the protocol, potentially culminating in insolvency.

This study presents a comprehensive blueprint for facilitating permissionless listing while mitigating protocol and user base risks. Although the potential risk to users is contemplated in this discourse, the primary emphasis is on striking a balance between protocol risk and permissionless asset listing. The fundamental premise of this solution is that the burden of prudence resides with the purchasers; however, we put forth a series of mechanism designs and an architectural framework aimed at curtailing overt market manipulation while preserving open markets that foster free market dynamics.

The process of permissionless listing is systematically dissected into three discrete phases: (1) prerequisites for asset listing, (2) the provisional period succeeding asset listing, and (3) the criteria for asset progression from probationary status to mature asset recognition. Additionally, this paper probes the conditions under which an asset might revert to probationary status or be subjected to delisting.

What's at stake?

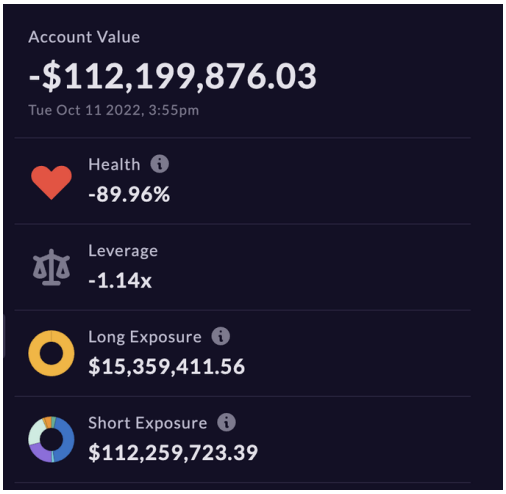
The protocol is accountable for the losses from **liquidated accounts** and **bad debt** derived from accounts where the position value has plummeted below zero pre-liquidation. The insurance fund absorbs these losses. Scenarios leading to bad debt can transpire without malicious actors, especially under market volatility coupled with leveraged accounts.

Exploits

Every new feature is a vehicle for protocol growth and a potential attack vector. The DeFi world is familiar with this concept. In fact, Cointelegraph approximates that such maneuvers resulted in over **$2.8 billion in losses** within the decentralized finance (DeFi) sector in 2022 alone. Exploits occur when malicious actors manipulate the price of an asset in order to execute a profitable trade. The profits come from the backs of honest users as well as the protocol. In extreme cases, an entire protocol can go insolvent in the blink of an eye.

Mango Markets

On October 11th, 2022, a malevolent trader assailed Mango Markets, a perpetual exchange leveraging the Solana blockchain. The perpetrator adeptly manipulated the platform's mechanisms to abuse its leverage offerings and the ability to procure loans against unrealized profits or losses (PnL). Consequently, the malevolent actor extracted over **$100 million in funds**. The efficacy of this exploit was partially due to the comparably thin liquidity of the $MNGO token. Coupled with the leverage positions on the perpetual exchange, the attacker could effectively inflate and deflate the price of MNGO, thus securing considerable profits.



Status Mango Markets perpetual exchange after the attack was completed. Source

Pump-and-Dumps

Beyond the imminent threat of hostile attacks, an equally unsettling risk exists associated with introducing long-tail assets. They are often used in pump-and-dump schemes. In such circumstances, the token creator's intention might not be to siphon funds from dYdX directly. Instead, they accumulate profits by offloading their asset onto unsuspecting traders in the spot markets. A revealing study by Chainalysis discovered that an alarming 24% of new tokens introduced in 2022 were embroiled in such **pump-and-dump schemes**. The admission of low liquidity assets on dYdX inherently imperils the financial stability of the protocol, potentially precipitating insolvency.

Telegram group Rocket Pump coordinates the timing and target entry/exit prices for pumps and dumps.

Fortunately, most pump and dump schemes are relatively simple to detect. They typically use long-tail assets with low trading volume and thin liquidity.

Market Instability

Outside of malicious actors, perpetual exchanges are also vulnerable to ‘depegs’ during periods of high volatility. Ideally, the mark price of a perpetual trades very closely to the assets index price. In periods of high volatility, the two prices may separate. This can lead to unnecessary losses for liquidated traders based on an inaccurate mark price.

BitMex Cascading Liquidations

On March 12th, 2020, the price of Bitcoin dropped from $7,200 to $5,678 in about 15 minutes. This flash crash caused over $702MM in cascading liquidations on BitMex, a perpetual exchange. The size of the liquidations created a backlog that caused a deviation between the price of Bitcoin on BitMex and its competitors. Around the same time, BitMex suffered an outage, preventing traders from placing and completing orders. This caused a bit of controversy as accusations of foul play were made.

Timeline of BitMex outage and price deviation from other exchanges.

Note the particularly severe depeg between 20:15 and 20:45. The price of Bitcoin on Bitmex held around $3,600. On other exchanges, Bitcoin's price had begun recovering. Liquidated longs may have been profitable if the Bitmex price followed other exchanges.

Perpetual Protocol v1 DePeg

Perpetual Protocol v1 is a smart contract-based decentralized Perpetual Exchange. It acted as a counterparty to all trades on its exchange. Markets were treated as virtual AMMs, and Perpetual Protocol would accept orders and calculate slippage according to the virtual AMMs pricing. This system allows Perpetual Protocol's market-making to maintain a near 0 PnL while keeping its prices close to the spot TWAP of its markets.

This system allows Perpetual Protocol's market-making to maintain a near 0 PnL while keeping its prices close to the spot TWAP of its markets. Unfortunately, Bitcoin flash crashed in February of 2021. This caused a significant price depeg on Perpetual Protocol due to cascading liquidations and a lack of limit orders on the exchange.

Price depeg between index price and mark price on Perpetual Protocol. Eventually, arbitragers corrected the price, but the protocol's traders suffered a loss. Source.

Trader activity was low then, causing the depeg to last for about an hour. Traders with open long positions suffered unnecessary losses while external arbitragers profited.

Things to Consider

As discussed, there are a variety of risks associated with listing assets on a perpetual exchange. Most risks can be mitigated with stringent market listing criteria, an effective liquidation process, and insurance fund. The drawback is the labor currently required to list assets. Thirty-eight assets are listed on dYdX at the time of writing. Expanding this to potentially thousands of assets isn't feasible without permissionless listing.

When designing permissionless listing, we want to draw attention to this trade-off between protocol risk and the ease of listing assets. The more assets listed, particularly long tail assets, the greater the risks to the protocol. A solution is to list many assets but with trading restrictions. The issue there is the impact on user experience. Users want limited trading restrictions along with low fees and deep liquidity. Listing 10,000 markets no one uses isn't a win for the protocol.

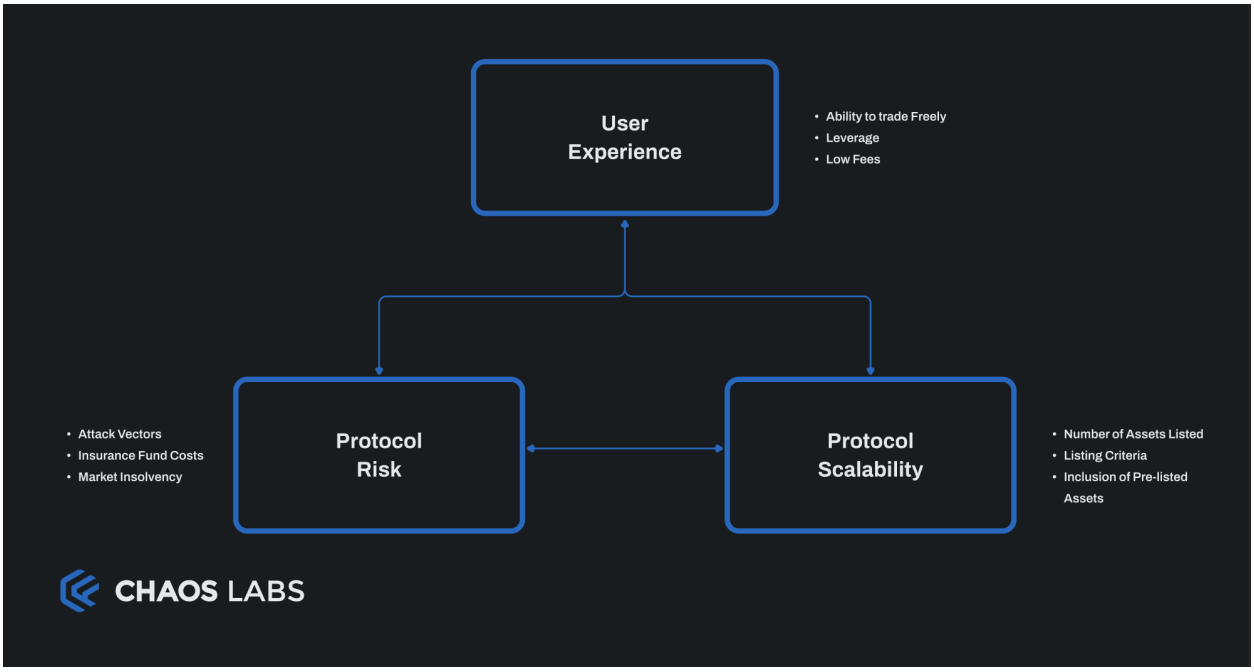
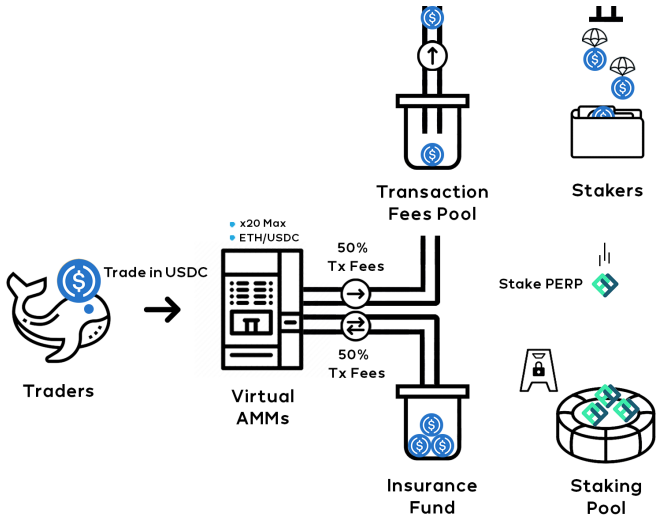


Diagram breaking down the trilemma of trade-offs when designing permissionless listing.

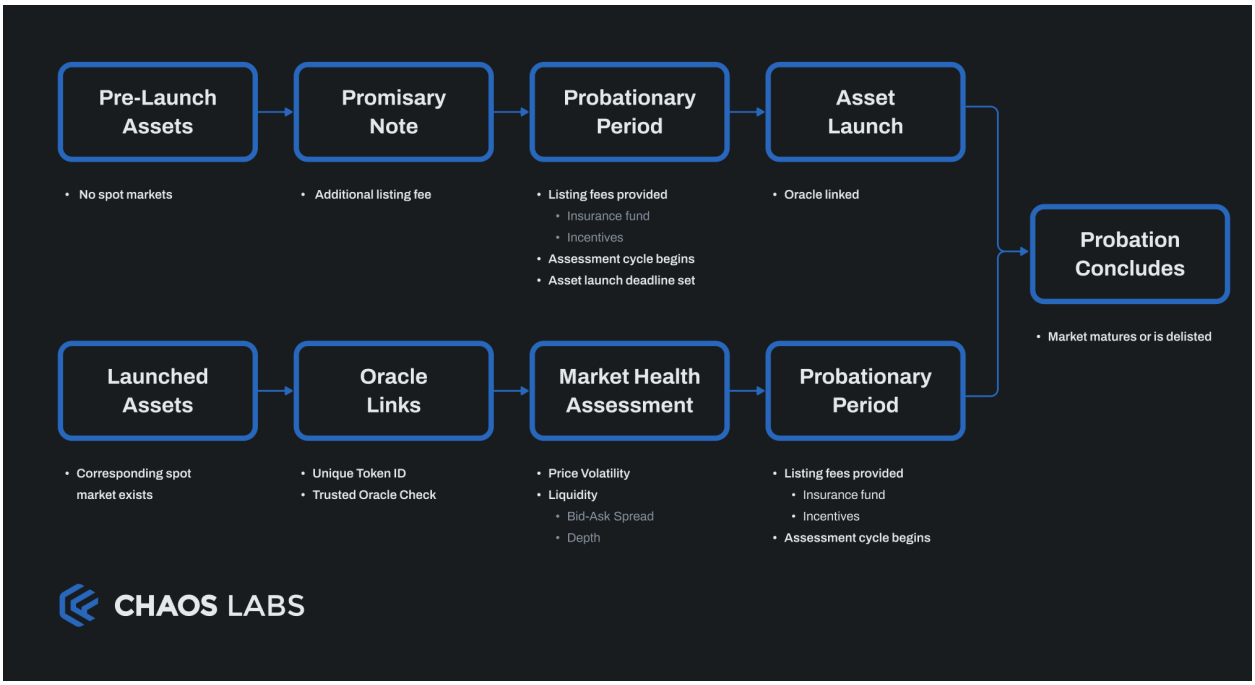


Perpetual Protocol v1 utilized a virtual constant product AMM to determine market liquidity. Source

Thus, we have this perpetual exchange trilemma. How do you list thousands of assets without significantly impairing user experience or putting the protocol at risk?

Market Listing Criteria

In healthcare, the assertion often holds that preventive measures yield greater dividends than curative interventions, a principle that fittingly extends to asset listing. The effective deterrence of illegitimate asset listing, which we define as assets deliberately forged by malicious entities with the express intent of destabilizing the protocol, decidedly outweighs the benefits of remedying the ensuing complications. Such a malevolent entity may possess an unlimited capacity to mint the contentious asset, may exert control over the asset's market (for instance, having constituted the Uniswap Liquidity Pools and independently furnished the liquidity), and may dictate the asset's trading volume through wash trading. In this section, we delineate two distinct market listings. First for assets with existing markets and second for pre-launch assets.



Summary of market listing and maturation process for pre-launch and launched assets.

Launched Assets

The core challenge in asset listing is identifying which assets constitute healthy markets. However, this begs the question, what is a healthy market?

Market Health Assessment/Score

The determination of a 'healthy' market may then hinge on its liquidity, order book spread, volatility of order book depth, and volume, necessitating a minimum number of such markets for listing. Preexisting listed assets can function as comparative benchmarks. Metrics for these listed assets can be formulated, requiring new assets to meet a performance-based threshold derived from these incumbent assets. Potential metric indicators might include:

- Duration of Trading History
- Daily Volume to Market Cap Ratio
- Daily Volume to Aggregate Liquidity Ratio
- Bid-Ask Spread
- Price Volatility (Hourly, Daily, and Monthly)
- Price Impact of a Swap (comparable to v3's impact notional amount for margin requirements)
- Quantity of Transactions/Trades
- Estimated Revenue

The aforementioned metrics can be compiled for assets listed under V3 and juxtaposed against the top 1000 assets to determine eligibility for listing. The same metrics can delist an asset with an established safety margin. For example, an asset's daily volume may be mandated to surpass 1% of its total liquidity for listing. It could face delisting if its daily volume falls below 0.5% of its total liquidity, thus establishing a 0.5% buffer. The volatility of these metrics would necessitate scrutiny when establishing these buffers.

When setting guides for eligibility, the trade-off between potential protocol growth and risk should be considered. If a low bar is set, many assets can be listed, but the risk of malicious assets being listed is higher. The bar for metrics can be moved over time as the number of assets listed grows, and the permissionless listing program evolves. As an example, here are some market health criteria based on the number of markets on dYdX:

Markets (M)	Market Cap	Trading History Duration (t)	Daily Transactions
M ≤100	Top 250	t ≥ 1 year	≥ 100,000
100 < M ≤ 1,000	Top 2,000	t ≥ 6 months	≥ 50,000
1,000 < M ≤ 2,500	Top 5,000	t ≥ 3 months	≥ 10,000
2,500 < M ≤10,000	Any	Any	≥ 1,000

Starting with tighter restrictions allows the program to be evaluated and improved without significant risk exposure. This allows protocol growth while mitigating potential risks.

Whitelisted Oracles

Now that we've formally defined market health, we face the practical challenge of sourcing the data for our on-chain protocol. Without a governance mechanism to validate asset legitimacy, our dependency shifts toward our whitelisted oracles. Utilizing oracles from exchanges that lack permissionless listing provides a method to ascertain an asset's authenticity. This constitutes a form of human vetting delegation to our oracle, albeit with the associated downside of subsequent dependency on external bodies such as centralized exchanges or data aggregators like CoinMarketCap or CoinGecko.

Pre-Launch Assets

For pre-launch assets, these metrics and oracles are unavailable. Consequently, listers should be allocated a timeframe to supply those oracles. This constrains a pre-launch asset's duration on the protocol before its launch and obliges attackers to function within a specific timeframe. A shorter timeframe may enhance safety but could generate friction as newly launched cryptocurrencies may not immediately be accessible on our Oracle providers. When supplying an Oracle feed for a now-launched pre-launch asset, its market data must not commence until after its listing on dYdX. This inhibits attackers from deceptively associating a pre-launch asset with an extant market.

Following this phase, the asset, having undergone stringent market evaluation and demonstrating activity and scale commensurate with trusted assets, is prepared for listing. A preliminary listing fee is requisite to prevent excessive asset listing. This fee could range from a nominal 25 dYdX to significantly higher amounts intended to deter malicious entities from listing assets, with the collected fees funneled into the insurance fund. While an exorbitant fee could deter users from listing, a balanced approach may involve levying a substantial fee (e.g., 10k USD), with the excess amount refunded to the lister should the asset eventually mature into a stable market. For pre-launch assets, a significant fee is mandatory.

Buyer Beware and Ascertaining Lister Commitment

The lister must assume responsibility for the pre-launch market's health, as the protocol cannot automatically vet the asset. This accountability, combined with the inherent risks of cryptocurrency trading and the value offered by a listing on a prominent exchange, warrants a substantial listing fee.

As substantiated by multiple industry sources, listing an asset on cryptocurrency exchanges can cost over $1 million. This is higher than the cost to list on most traditional stock exchanges and indicates the power and liquidity offered by cryptocurrency exchanges.

For comparison, the spot market listing fees for the NASDAQ and crypto exchanges:

Exchange	Estimated Listing Fee
NASDAQ	$270,000
Small Exchange	$5000 - $25,000

Medium Exchange	$60,000 - $300,000
Large Exchange	$1MM - $2.5MM

In light of this, a substantial listing fee for dYdX (e.g., 10k USD) is not unreasonable. This fee would deter malicious entities and ensure that listers have the resources and motivation to maintain the health of their listed markets. The fee balance is refunded to the lister if the asset matures into a stable market as a reward for maintaining a healthy market. For pre-launch assets, a substantial fee is essential to ensure the lister's commitment to maintaining the market's health in the absence of automatic vetting by the protocol.

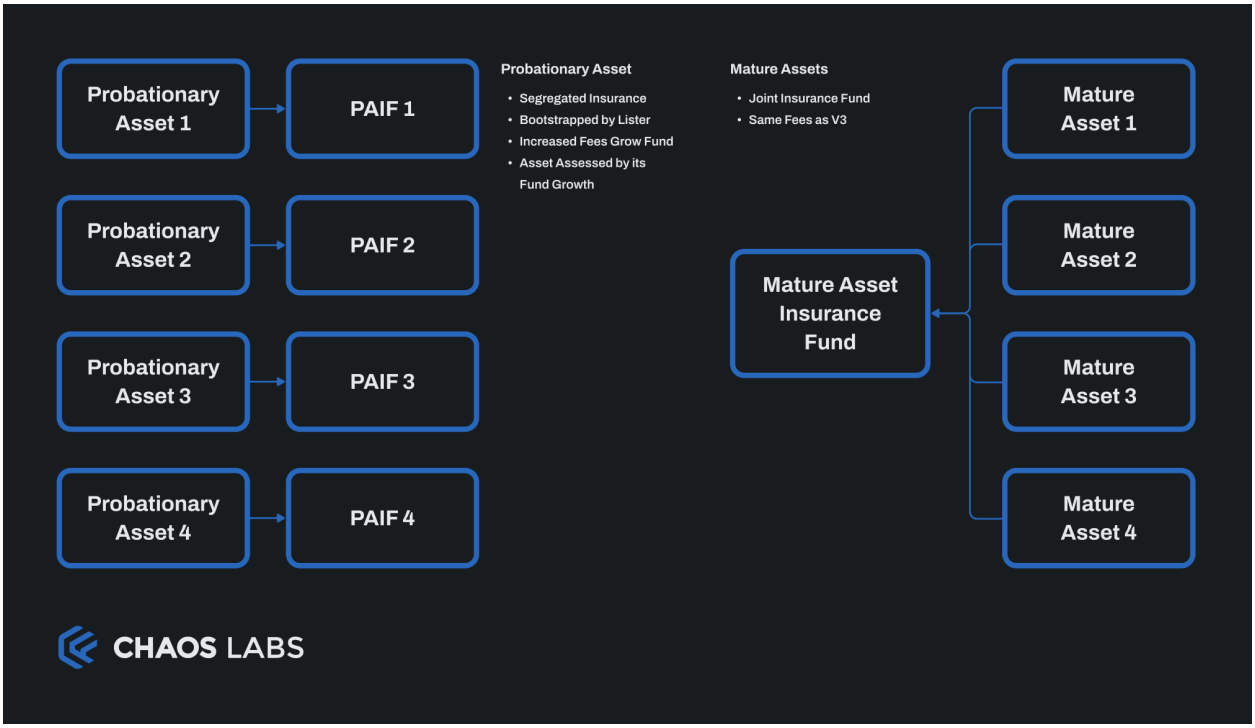
Post-Market Deployment

Upon successful listing, assets transition into a probationary period characterized by the imposition of additional risk mitigation strategies. Guidance advisors can be introduced for markets in the probationary phase. Such markets could be perceived as distinct experiences unrelated to the primary markets.

This segregation strategy aids in shielding low-risk users from inadvertently engaging in riskier activities beyond their typical risk profile. It also detracts from the implicit legitimacy that a market may accrue merely from being listed on a premier exchange such as dYdX. It is inevitable that, over time, a dubious asset prone to rug pull or pump-and-dump schemes will infiltrate a decentralized application (dApp) with permissionless listings. Thus, minimizing the protocol's risk exposure while effectively managing user expectations emerges as a critical non-tangible aspect of addressing this issue.

Probationary Asset Insurance Fund

The insurance fund serves as the principal safeguard against protocol insolvency. As of the documentation, the fund boasts a balance of **~$21m**, responsible for managing bad debts and liquidations for **~$312m in open interest across 38 markets**. With the advent of permissionless listing and probationary periods, a separate insurance fund catering to these markets, namely a Probationary Asset Insurance Fund (PAIF), is necessary. While the existing insurance fund, referred to as the Mature Asset Insurance Fund (MAIF), can be employed to seed the PAIF, the two must remain distinct entities.



Comparison of Probationary Asset Insurance Funds (PAIF) w/ the v3 insurance fund.

Separating the funds prevents an attacker from listing an asset, opening a position, manipulating its price, and then relying on the protocol's insurance to close its profitable positions.

If a probationary asset matures, its PAIF is sent to the MAIF. If a mature asset is sent to probationary status, then its PAIF is seeded by the MAIF. In this case, seeding would be calculated as follows:

$$\frac{OI_{asset}}{OI_{total}} * MAIF$$

This gives demoted assets a reasonable starting place for their funds while also providing a buffer between the demotion and promotion —see the below section on capitalizing the fund.

Capitalizing the Fund

A probationary assets insurance fund necessitates steady sources of capital. We suggest slightly increased trading fees to accomplish this. The fees accumulated for the fund could be progressively reduced as the fund's balance gravitates towards a stable point, an approach akin to gauging the health of margin accounts. The stable point suggested is a ratio of the fund's balance and the asset's open interest. Open interest represents the counterparty risk the insurance fund must cover.

Both historical and simulated payouts can inform the determination of an optimal ratio of fund balance to open interest. As an illustrative example using current trading **fees**, open interest, and insurance fund:

- Let B_m, B_p be the balance of the MAIF and the individual PAIF, respectively
- Let OI_m, OI_p be the open interest, in dollars, of all mature markets and the individual probationary markets, respectively.
- If $\frac{B_p}{OI_p} \leq 1.25 * \frac{B_m}{OI_m}$, set maker and taker fees two basis points above mature trading fees
- Else: set maker and taker fees one basis point above mature trading fees

Like the asset listing criteria, this model leverages the existing mature markets to formulate a health metric for the insurance fund. Alternative metrics are the balance-to-volume ratio or calculating the value at risk.

Heightened fees dissuade users from participating in probationary markets, a factor that should be considered when establishing fee structures.

Bootstrapping New Listings

New listings, particularly for pre-listing assets that do not have spot markets, need an initial source of liquidity. Existing market makers may not enter new markets, especially for long-tail assets. The uncertainty can outweigh the potential returns. To avoid a rush of illiquid markets, some liquidity bootstrapping is required.

Lister Liquidity Commitment

An additional mechanism is to require the asset lister to provide some initial liquidity to the market. To protect the lister, this liquidity will only be used for the first month the market is open. Additionally, the lister can select the price range in which they are willing to provide liquidity. For assets w/ spot markets, the range must be within the asset's average daily range. How narrow, and which part of the range is up to the lister. Pre-launch assets can have their initial price range set by the lister.

The initial liquidity commitment is held in USDC. This commitment provides the market's initial quote liquidity. As trading occurs, if the market has healthy volume and volatility metrics, the bond can be returned to the lister. This mechanism ensures market liquidity exists at market launch. It also mitigates malicious actors from listing an asset for pump-and-dump schemes and other purposes.

The drawback to this is the significant commitment required from the lister. If the protocol wishes to list thousands of assets, it's not advisable to ask listers to be market makers. For that reason, we do not advise requiring listers to provide liquidity. If dYdX wishes to be conservative at the start of its permissionless asset journey, this can be reassessed.

Market Maker Rebates

dYdX already has some form of market rebates in place. For probationary assets, additional rebates are advised. These markets can be more volatile, which can cause additional risks to market makers. Larger rebates offset this risk.

Probationary assets can have a flat rebate rate of 1.5 bps or a decaying rebate rate based on their progress in the probationary asset program. As an example, newly launched markets can start with a 2.0 bps and decay down to 1.1 bps when approaching maturation.

Curtailing Potential Losses

Having secured a robust insurance fund and delineated funding mechanisms, our focus can now shift toward mitigating potential losses for the protocol. It is crucial to remember that potential losses for the protocol also represent potential gains for attackers, as bad debt covered by the insurance fund is paid out to these malefactors. Fortunately, several strategies exist to limit the financial damage inflicted on the protocol (and its users, by extension).

Price Limits

Price limits are standard instruments in traditional and decentralized finance to moderate excessive price volatility. In the New York Stock Exchange (NYSE), for example, **circuit breakers** come into play when there is a significant price drop compared to the previous day's closing price. Such a precipitous drop suspends trading for a specified duration based on the extent of the price drop. Similarly, other perpetual exchanges enforce price limits leveraging the **last traded price** and **price changes over time**.

Exchange	Price Control	Details
NASDAQ	Circuit Breakers	Trading halts if price drops significantly in a given time frame.
Bybit	Price Limits	Highest permitted bid and ask price are based on the price of the last executed trade.

Perpetual Protocol	Price Change Limit	Price cannot change more than 2.5% in a 15 second timeframe
Binance	Price Limits	Limit orders are capped by the current mark price.
OKX	Price Limits	Limit orders are capped by the current index price.

Cap Activation Frequency and Asset True Range Percentage

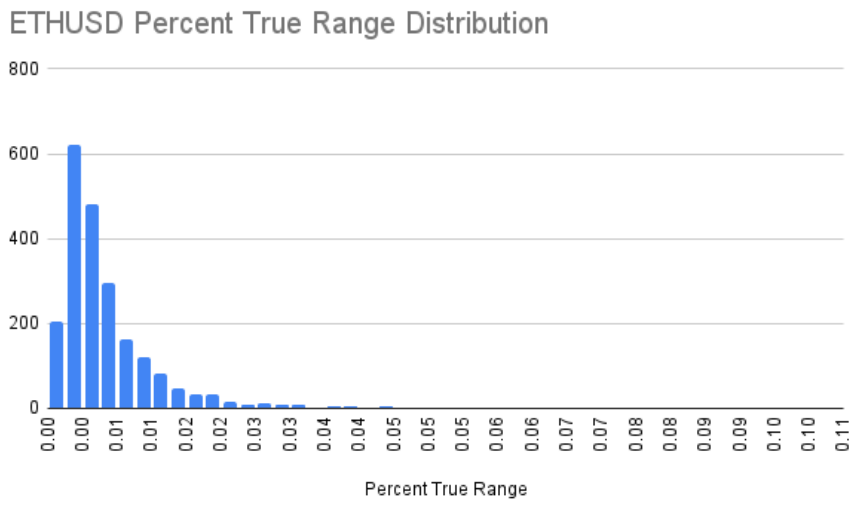
The precise cap can be informed by historical asset volatility. Caps can be designed to limit how often they are activated, thereby minimizing users' constant encounters with these caps. With a price cap, orders beyond the cap are not executed. Traders can set limit orders, transforming some takers into makers, or execute their trade at the capped price. An asset's price cap can either be set to a fixed percent or dynamically based on the asset's volatility. We suggest setting dynamic price limits using the asset's percentage true range price. The percentage true range price can be calculated as:

- Let TRP be the percentage true range of an asset price in a given timeframe.
- Let H be the high of an assets price in a given timeframe.
- Let L be the low of an assets price in a given timeframe.
- Let C be the closing price of the given timeframe
- Let C_p be the closing price of the prior timeframe

$$TRP = \max(\frac{H-L}{C}, \frac{|H-C_p|}{C}, \frac{|L-C_p|}{C})$$

A window, i.e., how far back to look, is determined along with a timeframe. For each timeframe, we calculate the TRP and then map its distribution. The price limit can then be set to a percentile of the TRP. A default price limit of 2.5% per 15 seconds can be used if an asset's price history is shorter than the desired window.

Using Kraken's public OHLCVT data, we've generated the distribution of TRPs for Ethereum for the window January 1st to March 31st:



Distribution of True Range Percentage for ETHUSD using one-hour timeframes

As the graph demonstrates, the majority of the time, our TRP is within 1%, TPR ≤0.01. Below is a breakdown of the higher end of the distribution.

Percentile	Percent True Range (%)
90	1.5
99	3.5
99.9	5.2
100 (Max)	10.4

On Kraken, the largest one-hour percent true range was 10%. 99.9% of the time, the percent true range is less than 5.2%. So, a price change limit of 5.2% per hour would keep the mark and index prices pegged 99.9% of the time.

Deviation of ETH Mark and Index Prices using a 5.2% hourly price limit

There are only three instances where the prices deviate within the 3-month timeframe. That's 3 out of about 2140 (3 months * 30 days/month * 24 hours/day) timesteps where the cap is triggered, which is about 0.14% of the time. An hour timestep and 3-month timeframe may be too large to account for sudden changes in market conditions. The exact percentile, window, and timestep sizes are calculated using simulations across various assets. Either way, the frequency at which price controls are triggered is entirely in the protocol's control. If an asset's trading history is shorter than the desired window, a predefined window can be used instead.

Price Limits in Action

With a price cap, sudden price manipulation can be dragged out over a significant period. Look at the Mango Markets attack referenced before:

A price cap can temper sudden price manipulation by extending it over a significant period. For instance, the price of MNGO was manipulated upwards by a factor of 30 (from approximately $0.03 to $0.90) within 10 minutes. With a cap for perpetual contracts, the time required to realize a similar price rise could be extended. Assuming a price cap such as the one used by Perpetual Protocol – a 2.5% change per 15 seconds– it would take around 137.7-time steps, or about 34.5 minutes, to raise the price of an asset 30 times, as demonstrated below:

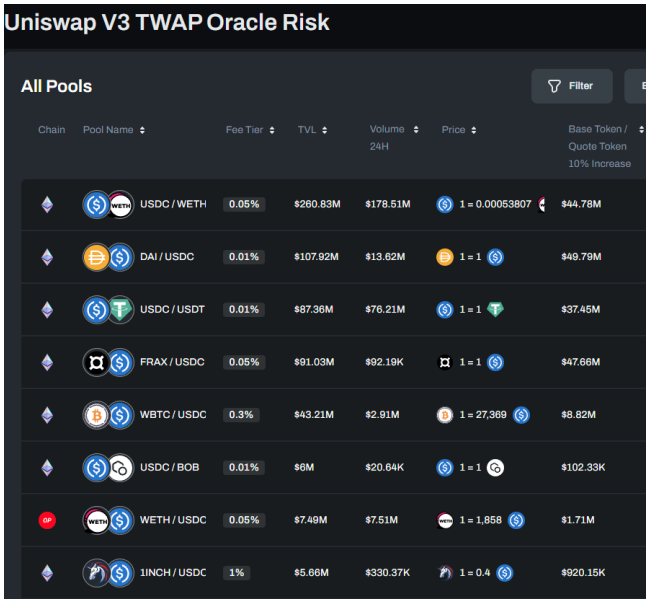
$$(1.025)^t = 30$$

$$log_{1.025}1.025^t = log_{1.025}30$$

$$t = log_{1.025}30 \approx 137.7$$

This is already longer than the duration of the attack itself and assumes that the perpetual's mark price is consistently 2.5% below the index price. Defending a manipulated price becomes challenging, as each minute of delay can cost the attacker a considerable sum, possibly into the millions, depending on the spot liquidity of the asset.

The deeper the liquidity, the more funds are required to move the asset's spot price. In some cases, this can cost tens of millions of dollars. In the case of Uniswap v3, Chaos Labs has a TWAP Oracle Risk Dashboard and the Uniswap V3 TWAP Market Risk Report that calculates the funds required to manipulate an asset TWAP:

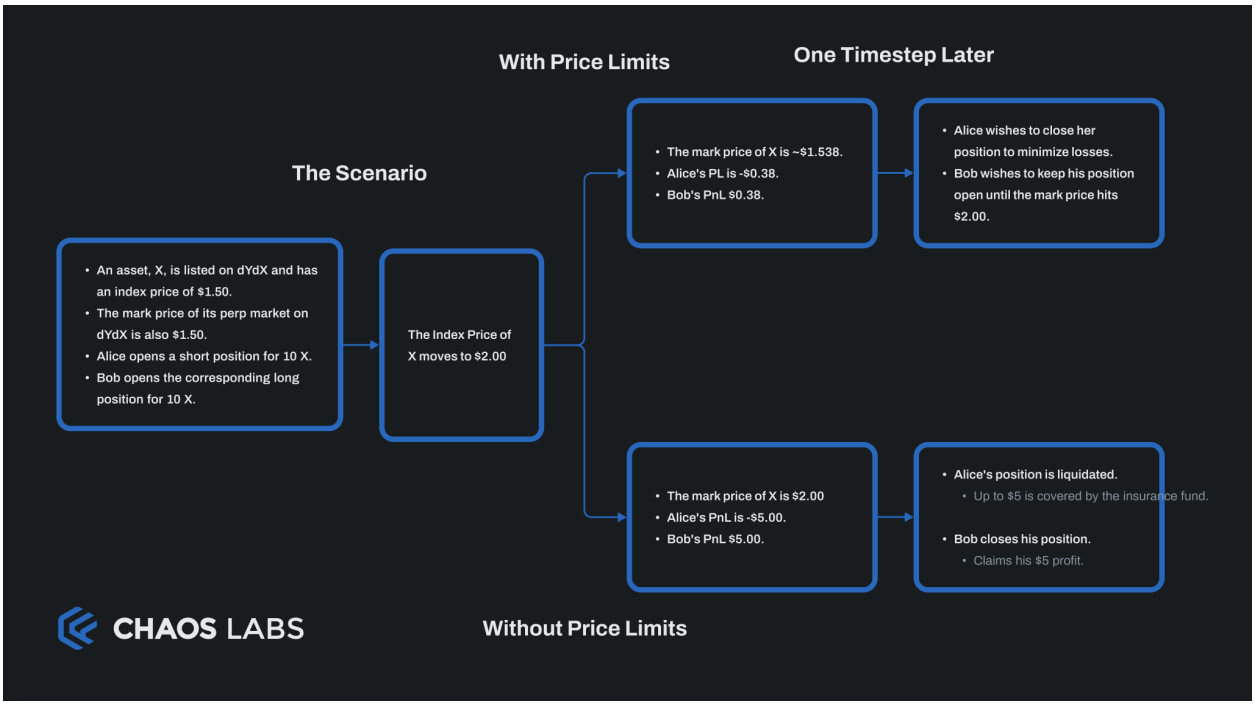


Capital Requirement to move an assets price by 10% in a set of USDC Uniswap v3 LPs

The USDC / WETH pool has ~$261M in liquidity, TVL in the image, and requires ~$45M in funds to manipulate the price by 10%. On the other end of this example, 1INCH / USDC has ~$5.7M in liquidity and only requires ~$920k to manipulate an asset's price by 10%. The increase in broader liquidity drastically impacts the feasibility of attacks.

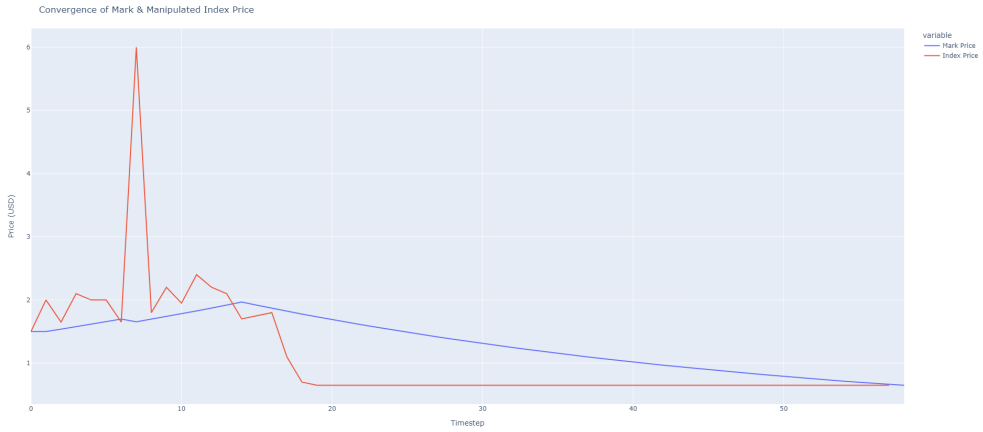
If an attacker manipulates an asset's price, the price limits engage and protect both users and the protocol. PnL caps and other mitigation strategies often curtail an attacker's profit without reducing a user's losses. This can deter trading as most traders are not attackers. Hence, a market where a trader's potential profit is limited, but losses could be total, may be unattractive to many participants. Let’s look at the following example.

Price Pump Example with Price Limits



The difference in trader PnL and action when using price limits in a perpetual market.

As shown in our example, a price limit causes a disconnect between the mark and index price during high volatility. This means that Alice and Bob must wait for the mark and index prices to converge over time. If the index price has been manipulated, it should revert to its intrinsic value at some point. For instance, in the case of MNGO, the asset's value dropped to $0.02 post-manipulation, representing a 33% decrease from its pre-attack price. Let’s simulate a similar set of events for our current scenario:



Convergence of the protocol’s mark price w/ a manipulated assets index price.

The price of X spikes suddenly and enters a period of high volatility. The mark price steadily adjusts by increasing until the manipulation is complete. At this point, the price of X crashes to $0.65, and the mark price decreases until they converge. In this example, the convergence takes 60 timesteps, which is about 15 minutes.

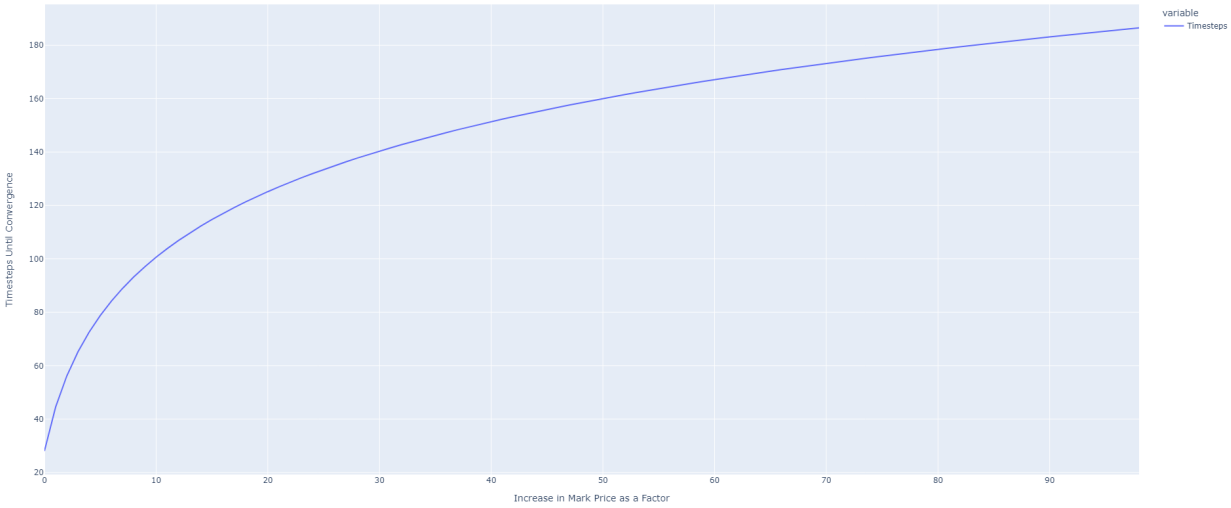
If Alice were queued for liquidation, her position would be liquidated at Timestep 14, when the mark price is about $1.97. Her position is worth -$4.70. This is better than the -$5 it would have been worth at the initial spike to $2.00. It's also significantly better than the losses she’d suffer if she were liquidated at $6. Either way, Bob still receives a profit, but Alice’s losses -and thus

the protocol's risk- is reduced. If Bob were an attacker, his attack cost would be less than $4.70. This cost would include trading fees and manipulating X's price for 15 minutes.

Even though the mark price ends below its starting point, Alice is still liquidated. Her being queued for liquidation isn't negated by the index price moving. Suppose her position is closed before her account regains a healthy status (i.e., her adding funds or the account value becoming positive again). In that case, she can keep her short open and eventually come into a profit.

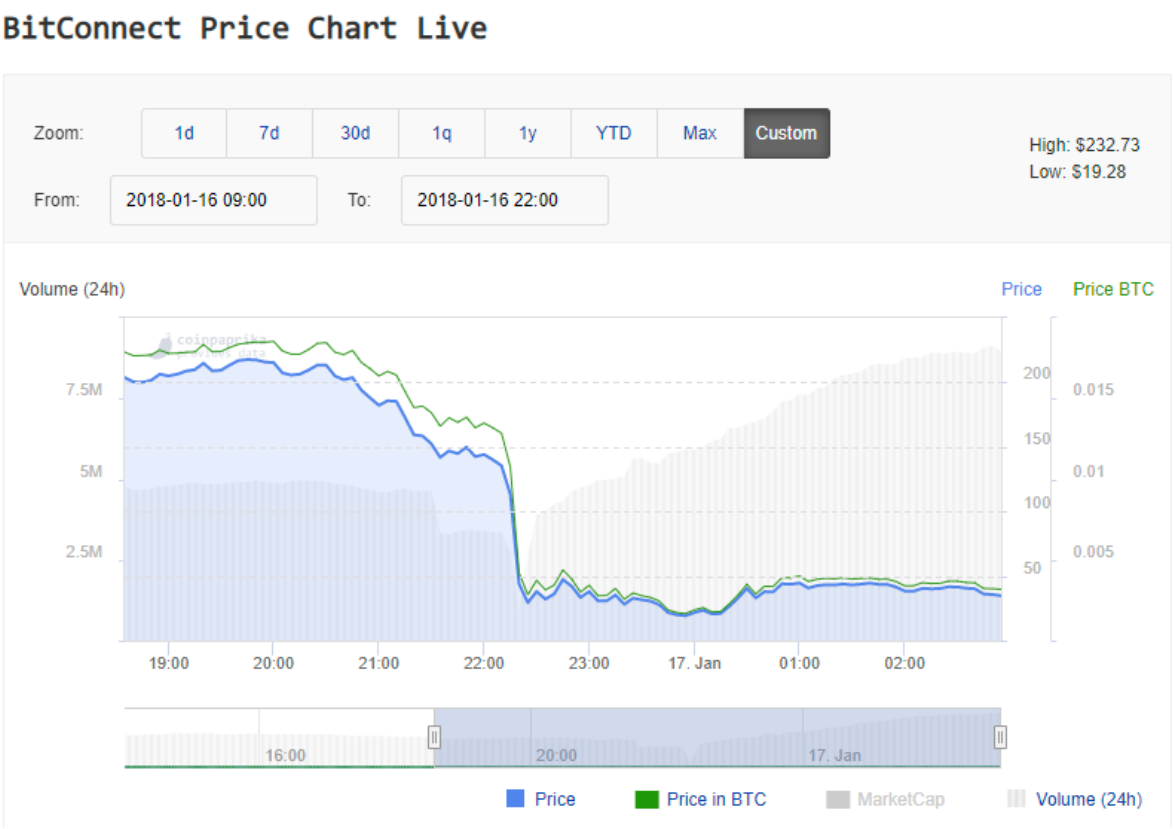
The result —who profits or loses— is the same despite the price limit. The difference is the magnitude of their PnLs.

What if there isn't an attacker? What if the price of an asset suddenly increases or decreases due to breaking news? The price limit isn't as prohibitive as it sounds. To demonstrate, we've simulated the number of timesteps taken to increase an asset's mark price by a given factor:



Timesteps are required for price convergence when a sudden increase in index price occurs

If an asset's index price doubles, it takes 28 timesteps (~7 minutes) for the mark price to catch up. A 100x asset price increase requires 187 timesteps (~47 minutes) for convergence. This assumes the price suddenly increases and holds. Such price movements, outside of manipulation, are exceptionally rare. Let's look at a real-world example of sudden price movements:



In 2018, Bitconnect was ousted as a Ponzi scheme and was forced to stop operations.

Bitconnect was served a cease and desist, and its price dropped over 90% in the weeks following. This was not an exploit or attack in any sense. This shows a specific period during Bitconnect's freefall. In about ~10 minutes, its price dropped 79% from ~$135 to ~$29. If Bitconnect were traded on a perpetual exchange with the above price limits, this price movement would take over 15 minutes. The index price would initially hit $29, and the mark price would be about $49. They would then converge a few minutes later. Otherwise, Bitconnect's price movement remained within the price limits.

The degree of price manipulation an attacker can cause is significantly limited with price limits. Despite that, traders should rarely run into this cap. This makes for a solid trade-off between reducing attack feasibility and trader freedom.

Limiting Leverage

Leverage is a potent tool when used wisely, but it can amplify the potential of an attack significantly. The main deterrent to an attack is the cost, followed by the capital requirement. An attack that costs $1 but requires $10 million to pull off is far less likely to occur than an attack that costs $1 and requires only $1 to pull off. With leverage, an attacker's capital requirement is reduced. If an attacker needs $10 million but can 10x leverage their funds, then they only really need $1 million. This presents a danger to the protocol; however, leverage is also one of the most attractive features of a DeFi protocol. The allure of amplifying profits tenfold through 10x leverage can be compelling.

Probationary assets should have lower leverage caps than their mature counterparts. Probationary Assets start with a leverage cap of 1.5x. Each week, the asset's market is assessed. If its insurance funds and price controls are healthy, see the table below, then its cap is increased.

We must assess the price limit mechanism to set requirements for reason expectations. With the price control cap, a window, W, timeframe, T, and percentile, P, is set. The expected number of times the price control cap is triggered, C, is then calculated as:

$$E(C) = \frac{W}{T} * (1 - P)$$

With the ETH/USDC example, we had a window of three months (2160 hours), a timeframe of 1 hour, and a percentile of 0.999 (the 99.9th percentile). This gives us an expected number of $E(C) = \frac{1month}{1hour} * 0.999 = 2160 * (1 - 0.999) = 2.16$. Values at or below this number can increase the cap. Values slightly above this number leave the cap, and values significantly above this number reduce the cap.

The price limits protect the protocol. We need to assess the user experience and determine if that is going well. A key metric to user experience is the liquidity available for trading. We've selected the spread, normalized by the mid-price, as our liquidity metric.

$$mid = \frac{ask + bid}{2}$$

$$spread = \frac{ask - bid}{mid}$$

Normalizing by the mid-price allows us to compare the spread across assets of different values. A second useful metric is the average 24-hour trading volume for a market. High volume indicates high liquidity and, thus, a healthy market, assuming no malicious actors. While wash trading is a concern, including price limits and spread metrics in our assessment limits the viability of wash trading. Wash trading would only be useful if an asset had a tight bid-ask spread and low price volatility compared to its historical data without generating sufficient volume.

These metrics are assessed at each Epoch, and the leverage cap is adjusted accordingly:

# of Price Limits Triggered	Bid-Ask Spread (% of mid price)	Avg 24hr Volume	Result
≤E(C)	≤0.20%	≥$850,000	Increase by .5x (Cap at 5x)
≤1.5E(C)	≤0.50%	≥$400,000	Remain the same
>1.5E(C)	>0.50%	<$400,000	Decrease by .5x (Floor at 1.5x)

The values used in this assessment are based on current spreads and volume on dYdX. In this example, a market's leverage cap is increased if its bid-ask spread and 24-hour volume would place at or above the 25th percentile of non-BTC/ETH markets. This is somewhat restrictive as each addition to the set of mature markets would raise the bar slightly. Similar to the discussion had on prelisted criteria, the bar can be lowered as the protocol grows and the permissionless listing program has been assessed:

Markets (M)	Increase Cap	Remain	Decrease
M ≤100	25th Percentile	10th Percentile	≥ Minimum
100 < M ≤1,000	10th Percentile	≥ Minimum	Metric Specific
1,000 < M ≤ 2,500	≥ Minimum	Metric Specific	Metric Specific
2,500 < M ≤10,000	Metric Specific	Metric Specific	Metric Specific

Note that minimum refers to the lowest value for mature markets at the assessment time. The metric-specific cells can be based on an analysis of the broader cryptocurrency markets. For example, if even microcap markets have spreads ≤2% on major exchanges, that can be used as the criteria for increasing the leverage cap.

The selectivity of the requirements must always be considered in the context of the trilemma. What level of risk is the protocol willing to take? Can a few probationary markets go insolvent? What % of probationary assets do we expect to be delisted vs mature? Based on those answers, the criteria can be refined.

A probationary asset with a 5x leverage cap for N consecutive epochs is flagged for maturation.

Let’s walk through an example asset:

Epoch	Cap	Price Limits Triggered	Bid-Ask Spread (% of mid price)	Avg 24hr Volume	New Cap	Comments
1	1.5x	0	2%	$200,000	1.5x	Met only one criterion, remains
2	1.5x	1	0.2%	$1,000,000	2.0x	Met all criteria; cap lifts one step
3	2.0x	4	0.50%	$260,000	2.0x	Met only one criterion, remains
4	2.0x	4	1.25%	$240,000	1.5x	Met all criteria; cap lowers one step
5	1.5x	1	0.12%	$900,000	1.5x	Met all criteria; cap lifts one step
…						
12	4.5x	0	0.04%	$1,500,000	5.0x	Met all criteria; cap lifts one step
13	5.0x	1	0.06%	$1,700,000	5.0x	Met all criteria, remains at cap
…						Remains at 5.0x for N epochs
20	5.0x	1	0.04%	$2,200,000	5.0x	Held 5.0x for N epochs, flagged as a potentially mature asset.

As shown above, an asset needs to meet every health market criterion to have its cap either lifted or lowered a step. Leverage is available the entire time, and the cap is dynamic based on asset performance. Users can partially close their positions or add additional funds to their accounts if the leverage cap decreases. In the meantime, the protocol can deleverage their accounts where possible. This addresses user experience concerns, as users entering leveraged positions comprehend that their leverage may be subject to recall if deemed necessary.

Asset Listing in Action

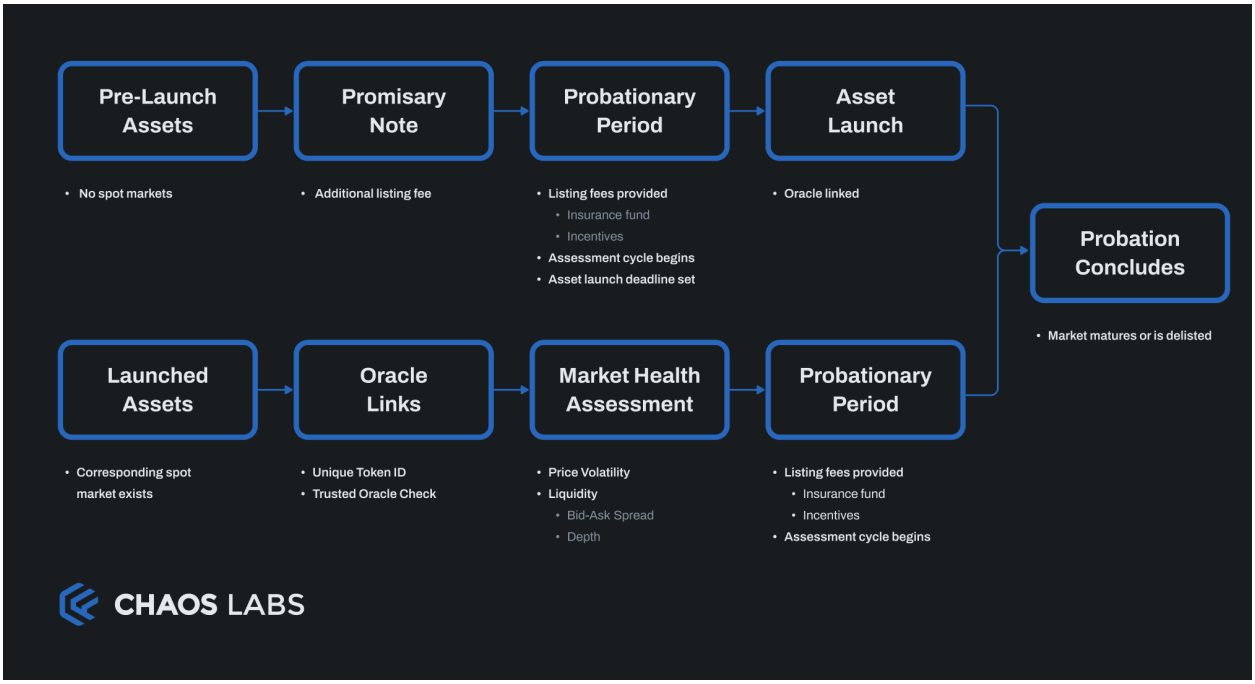
We’ve touched on various tactics that either grow the insurance fund, reduce losses, or both. Now, we shall demonstrate an example asset listing process.

Tactic	Purpose	Impact on Attacks	Impact on UX	Parameters
Separate Insurance Fund	Loss Reduction	Mitigates Attack	Minor	
Additional Fees	Fund Growth	Encourages Attack	Modest	Trading Fees
Price Limits	Loss Reduction	Mitigates attack	Moderate	Asset Volatility
Graduated Leverage Cap	Loss Reduction	Mitigates attack	Modest	Price Change Flags Insurance Payouts Other Flags

Separate insurance funds protect existing markets and the mass majority of funds and traders from potential attackers. A smaller fund for probationary assets also lowers potential profits for those attackers. The additional fees and price limits exist to grow and protect the insurance fund. They act independently and with different purposes. Growing the fund helps maintain protocol

solvency. Price limits mitigate attacks by reducing potential profits from attacks. They also increase the capital requirement for attacks by prolonging the duration an asset's spot price is manipulated.

On top of these mechanisms is the graduated leverage cap. The leverage cap time gates asset maturation and requires an asset to have a healthy perp market before increasing the protocol's exposure. The market is available for trading the entire time, so user experience is not significantly inhibited. This allows for permissionless listing and limits risk to the protocol. On a high level, the proposed mechanism design is architected as follows:



Summary of market listing and maturation process for pre-launch and launched assets.

Example 1 - Successful Asset Maturation

Phase 1 - Asset Assessment

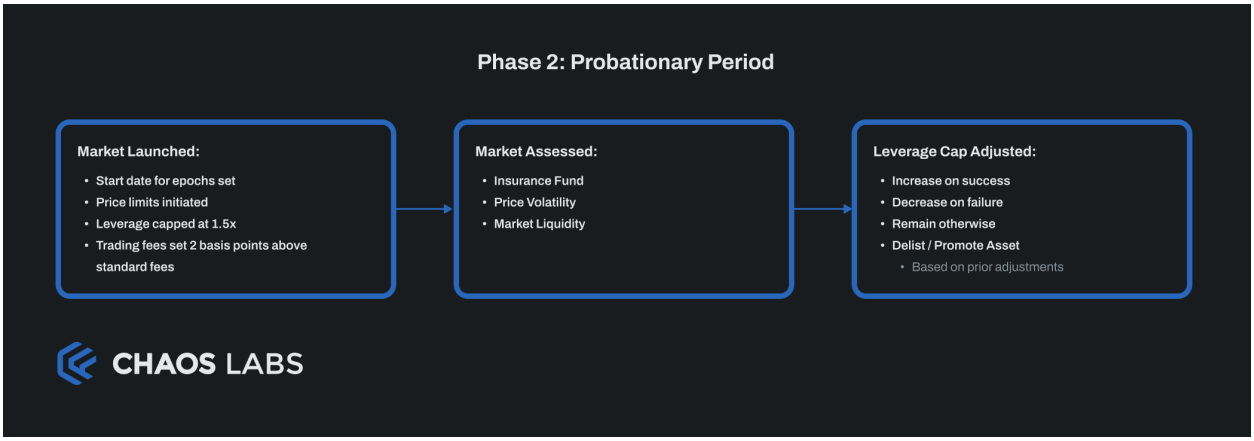
As an example, let's walk through an example permissionless listing process for Token X:

Initial asset assessment. An asset may be listed based on the number of markets on dYdX and the asset's performance.

The lister requests a perpetual market for Token X. They provide oracles, from our whitelisted set of oracles, that give the price history and market data for Token X. The lister also pays a modest listing fee as well as the initial insurance fund and incentives for the market.

With the listing complete, we begin our assessment phase.

Phase 2 - Probationary Period



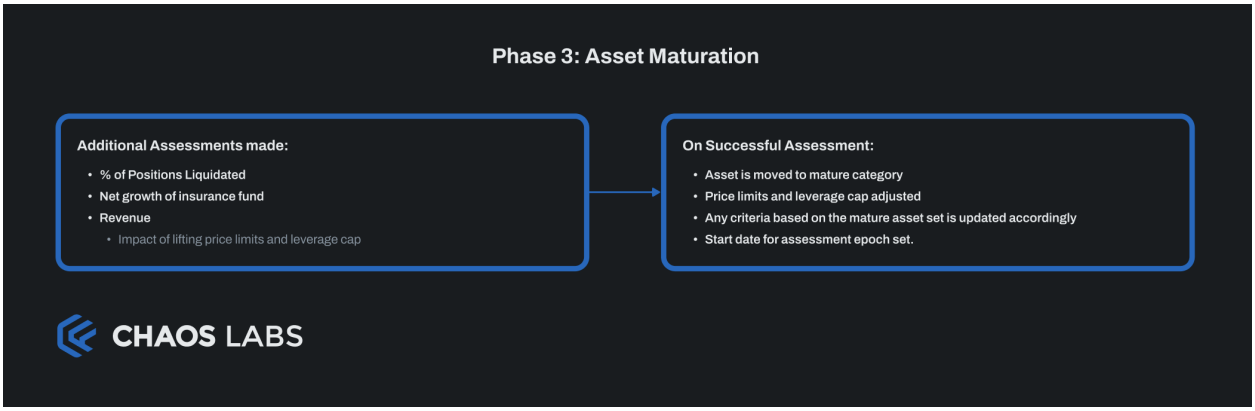
Probationary period assessment cycle. The market is assessed at each epoch until a promotion or delisting occurs.

Token X is listed as a probationary asset. Its listing date is the start date for the epoch system. Trading is enabled, and the probationary period begins.

Epoch	Leverage Cap	Price Limits Triggered	Bid-Ask Spread (% of mid price)	Avg 24hr Volume	New Cap	Comments
0	1.5x	—	—	—	—	Asset initially listed, the probationary market is open
1	1.5x	0	2%	$200,000	1.5x	Met only one criterion, which remains
2	1.5x	1	0.2%	$1,000,000	2.0x	Met all criteria; cap lifts one step
…						
12	4.5x	0	0.04%	$1,500,000	5.0x	Met all criteria; cap lifts one step
13	5.0x	1	0.06%	$1,700,000	5.0x	Met all criteria, remains at cap
…						Remains at 5.0x for N epochs
20	5.0x	1	0.04%	$2,200,000	5.0x	Held 5.0x for N epochs, flagged as a potentially mature asset.

Token X has had healthy price volatility and trading volume for multiple Epochs. It also held a 5.0x leverage cap. Now it is flagged for maturation, and on the 21st epoch, it can be assessed.

Phase 3 - Asset Maturation



Asset maturation process. Once an asset matures, the restrictions from the probationary period are lifted.

With Token X flagged, a final check is implemented before it can be matured. This check occurs every Epoch until its leverage cap is decreased (due to underperformance) or the maturation requirements are met. The requirements are as follows:

Metric	Probation Promotion	Maturity Demotion	Asset Delisting
% Positions Liquidated	≤ 5%	≥ 10%	≥ 20%
Revenue	≥ Insurance Payouts	≤ 75% of Payouts	≤ 50% of Payouts

Token X’s performance is:

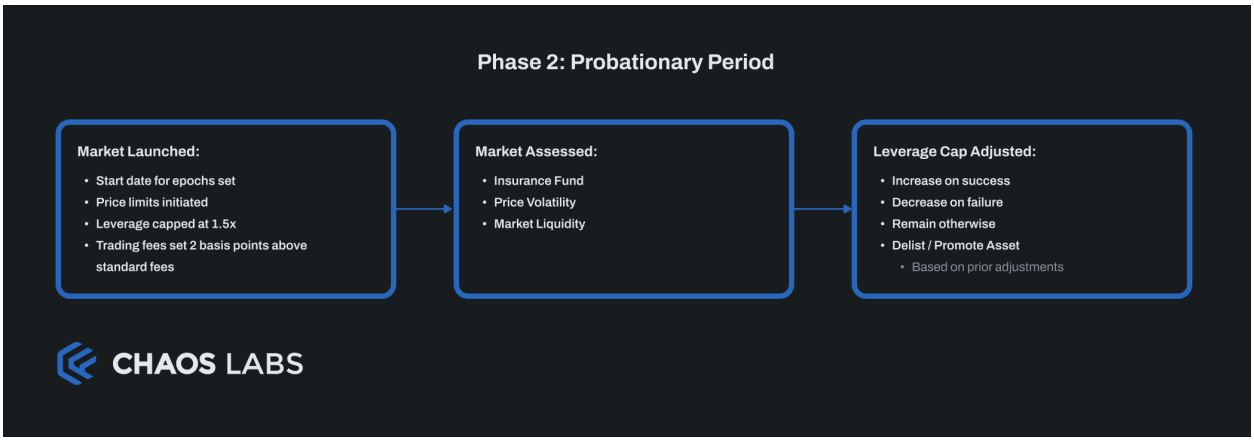
Epoch	% Positions Liquidated	Revenue	Comments
21	10%	1.25x Payouts	Meets one condition, remains on probation
22	4%	1.1x Payouts	Meets both conditions, becomes a mature asset

After 22 Epochs, Token X is a mature asset. Its leverage cap is increased to 10x, the same as other non-ETH/BTC assets on dYdX. It now has access to the larger insurance fund as well, and its trading fees revert to normal. Token X’s segregated insurance fund is then sent to the mature asset insurance fund.

Example 2 - Failed Asset Maturation

Token Z, similar to Token X, is an asset with a spot market listed on dYdX. It goes through the same phase 1 listing process and enters the probationary period.

Phase 2 - Probationary Period



Probationary period assessment cycle. The market is assessed at each epoch until a promotion or delisting occurs.

Token Z is listed as a probationary asset. Its listing date is the start date for the epoch system. Trading is enabled, and the probationary period begins.

Epoch	Leverage Cap	Price Limits Triggered	Bid-Ask Spread (% of mid price)	Avg 24hr Volume	New Cap	Comments
0	1.5x	—	—	—	—	Asset initially listed, the probationary market is open
1	1.5x	0	2%	$200,000	1.5x	Met only one criterion, which remains
2	1.5x	1	0.2%	$1,000,000	2.0x	Met all criteria; cap lifts one step
…						
12	1.5x	5	0.14%	$500,000	2.0x	Met all criteria; cap lowers one step
13	1.5x	4	0.26%	$17,000	1.5x	Met all criteria; remains at cap floor
…						Remains at 1.5x for N epochs
20	5.0x	5	0.04%	$2,200,000	5.0x	Held 1.5x for N epochs

Token Z has remained at a a 1.5x leverage cap for N epochs. It is removed from the protocol, and all positions are settled. The date of asset delisting is noted, and Token Z cannot be relisted for 30 days.

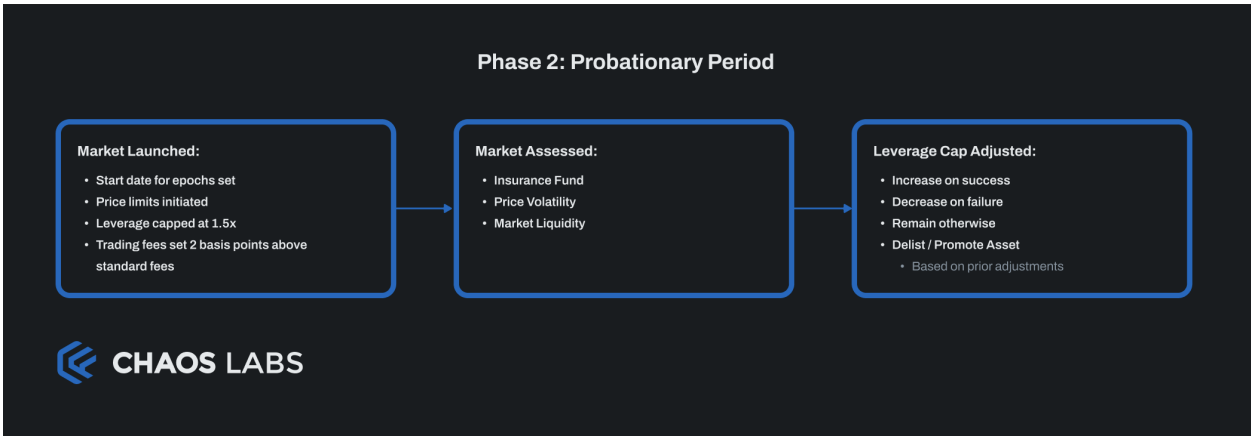
Example 3 - Pre-Launch Asset Process

In this example, we will look at Token Y, a pre-launch asset with no spot markets.

Phase 1 - Asset Listing

As Token Y has no spot markets, the lister does not need to provide any oracles. Instead, they pay a larger listing fee of $10k. This larger fee deters attackers and provides a larger insurance fund to account for potentially increased volatility.

Phase 2 - Probationary Period



Probationary period assessment cycle. The market is assessed at each epoch until a promotion or delisting occurs.

Token Y is listed as a probationary asset. Its listing date is the start date for the epoch system. Trading is enabled, and the probationary period begins.

Epoch	Leverage Cap	Price Limits Triggered	Bid-Ask Spread (% of mid price)	Avg 24hr Volume	New Cap	Comments
0	1.5x	—	—	—	—	Asset initially listed, the probationary market is open
1	1.5x	0	2%	$200,000	1.5x	Met only one criteria, remains
2	1.5x	1	0.2%	$1,000,000	2.0x	Met all criteria, cap lifts one step
…						
12	4.5x	0	0.04%	$1,500,000	5.0x	Met all criteria, cap lifts one step
13	5.0x	1	0.06%	$1,700,000	5.0x	Met all criteria, remains at cap

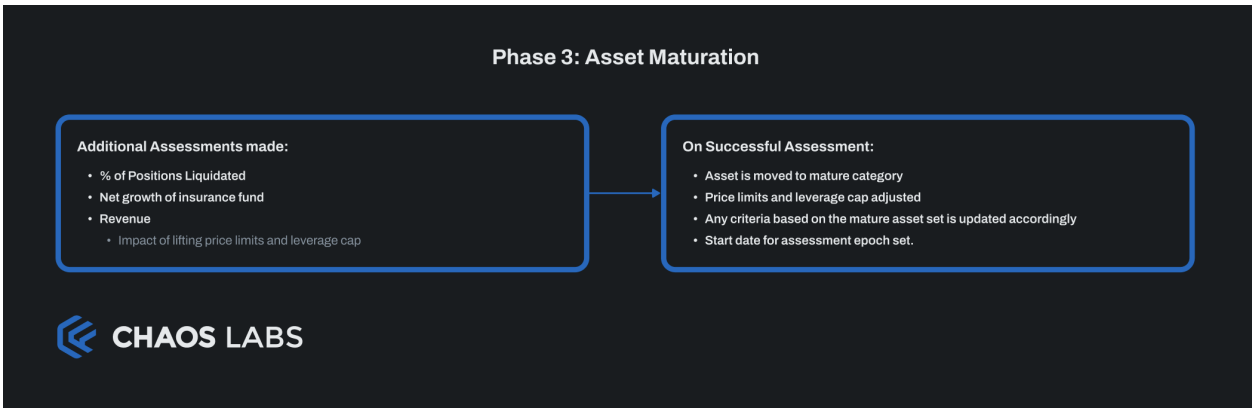
Token Y has a healthy price volatility and trading volume for multiple Epochs. Allowing it to hit the 5.0x leverage cap for probationary assets. Token Y *cannot* be flagged for maturation until it launches. It must hold a 5.0x leverage cap for N Epochs *after* its listing.

When Token Y is listed, its probationary process continues the same as Token X’s from before:

Epoch	Leverage Cap	Price Limits Triggered	Bid-Ask Spread (% of mid price)	Avg 24hr Volume	New Cap	Comments
14	5.0x	1—	—0.04%	$1,250,000	5.0x	Token Y’s spot market launches.

Epoch	Leverage Cap	Price Limits Triggered	Bid-Ask Spread (% of mid price)	Avg 24hr Volume	New Cap	Comments
…	1.5x	0	2%	$200,000	1.5x	Met only one criteria, remains
22	5.0x	1	0.04%	$2,200,000	5.0x	Held 5.0x for N epochs, flagged as a potentially mature asset.

Phase 3 - Asset Maturation



Asset maturation process. Once an asset matures, the restrictions from the probationary period are lifted.

With Token Y flagged, a final check is implemented before it can be matured. This check occurs every Epoch until its leverage cap is decreased (due to underperformance) or the maturation requirements are met. The requirements are as follows:

Metric	Probation Promotion	Maturity Demotion	Asset Delisting
% Positions Liquidated	≤ 5%	≥ 10%	≥ 20%
Revenue	≥ Insurance Payouts	≤ 75% of Payouts	≤ 50% of Payouts

Token X’s performance is:

Epoch	% Positions Liquidated	Revenue	Comments
23	25%	1.1x Payouts	Meets one condition, remains on probation
24	3%	1.2x Payouts	Meets both conditions, becomes a mature asset

After 24 Epochs, Token Y is a mature asset. Its leverage cap is increased to 10x, the same as other non-ETH/BTC assets on dYdX. It now has access to the larger insurance fund as well, and its trading fees revert to normal. Token Y’s segregated insurance fund is then sent to the mature asset insurance fund.

Conclusion

Overall, this probationary market system allows dYdX to segregate its risk. Newer listings cannot render the entire protocol insolvent. Instead, dYdX can choose how strict a listing criteria it wants. This way, the protocol controls how much risk it takes on versus how many markets it can list. With price limits, dYdX is adopting industry best practices as well. Price limits will not significantly impact UX and are a restriction most perpetual traders use. All the other metrics are simple assessments of market

health. Users are expected to do their research and choose assets wisely, but if they wish to trade something, they’re far more likely to find it on dYdX once the permissionless listing is live. If it's not on dYdX, they can even list it themselves at some point.