Leverage Tokens Without Decay

The ELI5 paper

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Decayless

October 2026

Status. This is the ELI5 paper, one of three. It explains Decayless from scratch. The short paper goes through the same design in more depth, and the full paper has the mathematics, with each result marked as proved, checked by a script, or still open. The same verification scripts compute the numbers in all three papers, and we typed none of them in by hand.

1 The whole idea on one page

A Decayless token moves a fixed multiple of the price of ETH, the currency of the Ethereum blockchain and the asset in all our examples. The ETH behind it already sits in a shared pot, which a fixed rule divides according to the price. The design borrows no money and does no rebalancing, and no one can force a sale. You get the full multiple for as long as the pot has room to pay it.

Suppose ETH rises 10% and you would like to make about 20%. An investment that moves more than the thing it follows is called leveraged, and one that moves twice as much is called 2x ("two times"). The common ways to get leverage all come with a catch. Borrow to buy more, and a dip can end in a forced sale. Hold a futures contract, and every few hours you pay or receive a payment called funding, which a bet on a rise usually pays when many traders want to make the same bet. Buy a ready-made leveraged token, and it slowly loses value when the price zigzags, a leak called decay. Section 2 describes all three and runs the last one with numbers.

Decayless offers leverage tokens without decay. A Decayless token is a share of a pot of ETH that already exists, and two groups own that pot. As the price moves, a fixed rule shifts ETH between them. We set the rule so that a 2x token pays exactly what a 2x should, whatever route the price took to get where it is. In the product's own words:

No decay. No funding. No liquidations. One fee, covering entry and exit; nothing while you hold. Full leverage while the pool has headroom. If price runs past the pool's headroom, your leverage compresses; it never liquidates.

The last two sentences are the fine print, and most of what follows is about them. *Headroom* is how far the price of ETH can rise before the pot can no longer pay the full multiple. Past that point your token keeps gaining as ETH rises, but by less than its multiple. It is never sold off, and if the price comes back down, it gets its full multiple back.

Sections 2 to 4 are the core of the explanation: why leverage usually hurts, how the pot works and what headroom means. After them, Section 5 adds the other leverages and Section 6 the fees. If you are thinking of taking the other side of the trades as a liquidity provider, Section 7 is written for you. Section 8 covers what other traders can do to your position, Section 9 collects what the design does not promise, and Section 10 lists the words we use. A reader in a hurry can read Sections 3, 4 and 9 and stop there.

2 Leverage usually comes with a catch

Suppose you buy $1,000 of ETH. ETH (ether) is the currency of Ethereum, a public blockchain, which means a shared online ledger that anyone can use and no single party owns. You can buy ETH with dollars, and its dollar price moves daily, often by several percent. We use ETH in all the examples, but the design works the same way for other assets.

Holding plain ETH, you get its move. If ETH rises 10%, you gain 10%. Leverage multiplies that move. With 2x leverage, a 10% rise gains you about 20%, and a 10% fall loses you about 20%. People use it when they expect a price to move and want more of the move, and it cuts both ways.

There are three usual ways to get it, and they all come with a catch.

- You can borrow. Put in your own money, borrow the same amount again, and buy twice as much ETH. Your gains and losses are now doubled. But the lender wants its money back. If ETH falls far enough that your own money is nearly used up, the lender sells your ETH to repay itself, even if the dip lasts a minute and the price recovers the next day. By then your ETH has been sold and the loss is locked in. That forced sale is called a *liquidation*, and a stockbroker offers the same arrangement under the name of a margin loan.
- You can hold a futures contract. Exchanges sell contracts called perpetual futures, which pay a multiple of the move in ETH without you owning any ETH. They liquidate too. Every few hours the two sides of the contract also settle a payment called *funding*, which keeps the price of the contract near the price of ETH. You can pay it or receive it, but a bet on a rise usually pays it when many traders want to make the same bet, and over months those payments add up.
- You can buy a leveraged token. Some exchanges and apps sell tokens that aim to deliver 2x of the daily move. They don't liquidate you, but to stay at 2x they have to *rebalance* daily, buying more ETH after a rise and selling some after a fall. When the price zigzags, buying after a rise and selling after a fall loses a little at each turn.

That last step is the weak one, and Table 1 shows how much it loses on one up-and-down trip. ETH starts at $1,000, rises 10% to $1,100, falls 10% to $990, then climbs back to $1,000. A token that doubles the move of each day goes from $1,000 to $1,200, then $960, then $979. ETH is back where it started, and the rebalancing token has lost 2% on a trip that went nowhere. That loss is called *decay*.

This shows most clearly on day two. ETH was down 1% from the start, and the rebalancing token was down 4%, four times as much as ETH where you would probably expect twice.

The Decayless 2x token in the last column behaves differently, for reasons Section 3 explains. Its value depends only on where ETH is today, whatever route ETH took to get there. On day two it is down 2%, twice the loss of ETH, and on day three it is back at $1,000, where it started. On day one it stands at $1,210, a little more than a plain doubling of the move, because on a big move its gains build on each other (Section 3).

Table 1: Decay in three days: $1,000 in a token that doubles each day's move, and $1,000 in the Decayless 2x token, while ETH goes up, down, and back to where it started. Values in dollars, rounded to the dollar, before fees.

	ETH's move that day	ETH price	Rebalancing 2x token	Decayless 2x token
Start	–	1,000	1,000	1,000
Day 1	+10%	1,100	1,200	1,210
Day 2	−10%	990	960	980
Day 3	+1.0%	1,000	979	1,000

But three days is a short trip. Figure 1 runs a longer one, 60 days in which ETH moves at random by up to about 10% a day in either direction. At one point it is 29% above where it started, at another 27% below, and it ends 20% higher. Holding ETH turns $1,000 into $1,200. The rebalancing 2x token turns it into $1,185, which is *less* than simply holding ETH, because the zigzags ate everything the leverage should have added.

Over the same two months the Decayless 2x token turns it into $1,440, which is what a 2x should pay for a rise of 20% (Section 3). Any other route to the same final price would have paid the same amount, as long as the pot had room along the way (Section 4). On this route it did.

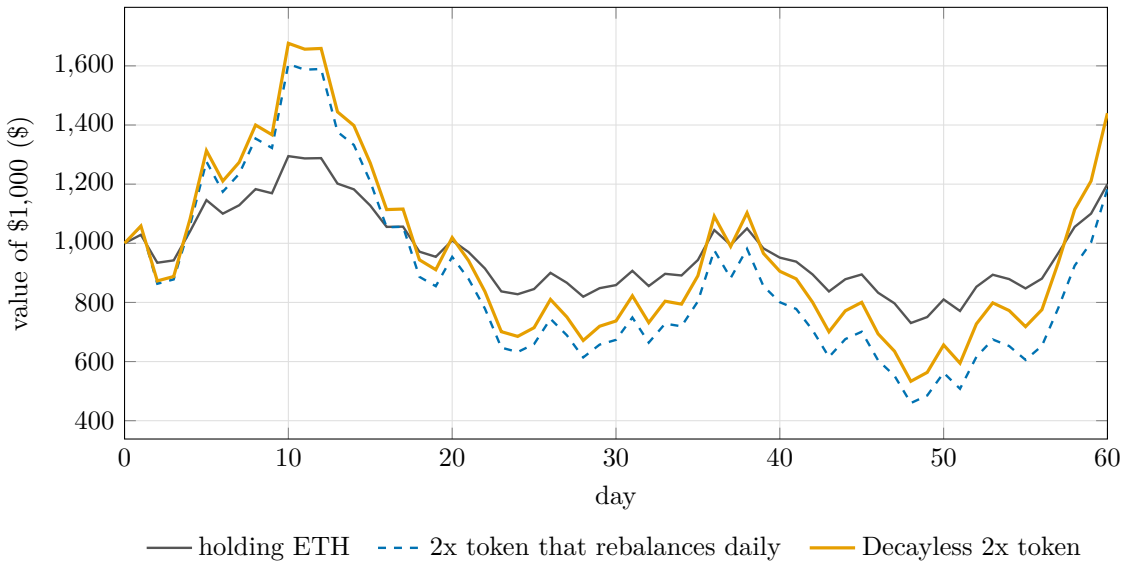


Figure 1: Two months of random daily moves, with the same amount in each product on day zero. The rebalancing token ends below plain ETH. The Decayless token ends where a 2x should for ETH's overall rise, whatever the route. The route is a computer-generated coin-flip sequence chosen for illustration, not a forecast.

Real funds have shown the same pattern. In 2009 the SEC and FINRA published an investor alert about leveraged exchange-traded funds, which aim for a multiple of the daily return of an index. Its example ran from December 2008 to April 2009. Over those months one index gained 2%, while a fund that sought twice its daily return fell 6%. Another index gained about 8%, and a fund that sought three times its daily return fell 53%.

Crypto has had leveraged tokens of the same kind. According to the walkthrough in the FTX help center, the leveraged tokens of FTX rebalanced once a day, and also during the day if a move pushed their leverage 33% above its target. According to its own support page, Binance aimed to keep its leveraged tokens within a target range of 1.5x to 3x. Index Coop built ETH2x-FLI on Ethereum itself, a token that targets 2x, and under the initial parameters in its launch announcement, a rebalance left its leverage between 1.7x and 2.3x.

3 One shared pot with two kinds of owner

Decayless starts from ETH that is already there. It is a set of *smart contracts*, programs that run on a public blockchain and hold money according to their code, and for each asset they keep one pot of ETH, called the *reserve*. The ETH in the reserve is owned outright, with no loan behind it, and it is held in the contracts themselves. Two groups own it (Figure 2):

- Traders hold *leverage tokens*. A token is a digital certificate of ownership that's kept in a crypto

wallet, and you can sell it back at any time. A leverage token is a share of the traders' part of the reserve, sold at a fixed multiple: 1.25x, 1.5x, 2x or 3x.

- Liquidity providers, or LPs, deposit ETH to fill the other part, called the *pool*, and get *LP tokens* in return as their share of it. The pool takes the other side of all the leverage tokens. When ETH rises, the pool pays the traders in ETH, and when it falls, the ETH of the traders flows back to the pool. LPs are paid fees for taking that side (Section 7).

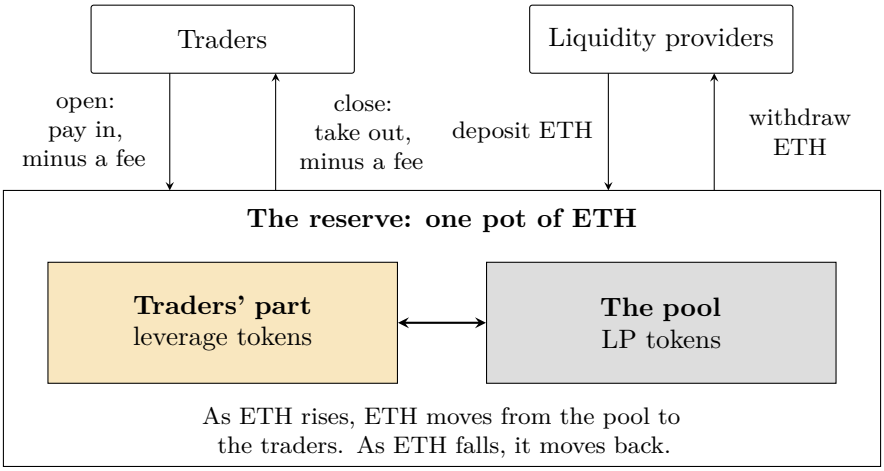


Figure 2: Who owns the reserve. Nothing is borrowed. Each side is worth its share of the ETH at the current price.

Now put numbers on it. Imagine a reserve of 100 ETH while ETH costs $1,000, a pot worth $100,000. To keep the numbers simple, it backs a single leverage token, the 2x. The 2x tokens of the traders own 25 ETH ($25,000), and the pool owns the other 75 ETH ($75,000). That's a simplification. In practice a real pool backs four leverage tokens at once, and Section 5 adds the other three.

As the price of ETH moves, a fixed rule decides how much of the ETH in the reserve belongs to the traders. When ETH rises, the pool hands the traders some of its ETH, and when ETH falls, that ETH flows back to the pool. For a 2x token we set the rule so that the ETH of the traders grows in the same proportion as the price.

Suppose ETH rises 50%, from $1,000 to $1,500, which multiplies the price by 1.5. Two things then happen to the traders' side at once:

- It holds more ETH, since its 25 ETH become 37.5 ETH, multiplied by 1.5.
- Each of those ETH is worth more, also multiplied by 1.5.

So the dollar value of the traders' side is multiplied by 1.5 twice, which makes 2.25. It goes from $25,000 to $56,250, a gain of 125% for a rise of 50% in ETH.

That is more than twice the rise of ETH, because the 2x in the name describes small moves. On small moves this is the familiar 2x. If ETH rises 10%, the 2x token rises 21%, and if ETH falls 10%, the token falls 19%.

Multiplying a number by itself is called *squaring* it. That puts the rule in one sentence: *the dollar value of a 2x token follows the square of the price.* For a 3x token the rule multiplies three times, which gives the *cube* of the price. The 1.25x and 1.5x tokens follow gentler versions of the same rule, and Section 5 gives their numbers. Table 2 and Figure 3 show the whole example at several prices.

Table 2: The example's reserve at six ETH prices, showing how much ETH each side owns and what it is worth. The two ETH columns always add up to 100 ETH. The traders' dollar value follows the square of the price up to $2,000, and Section 4 explains what happens above that price. Before fees.

ETH price ($)	Traders' ETH	Traders' value ($)	Pool's ETH	Pool's value ($)
500	12.5	6,250	87.5	43,750
1,000	25.0	25,000	75.0	75,000
1,500	37.5	56,250	62.5	93,750
2,000	50.0	100,000	50.0	100,000
3,000	66.7	200,000	33.3	100,000
4,000	75.0	300,000	25.0	100,000

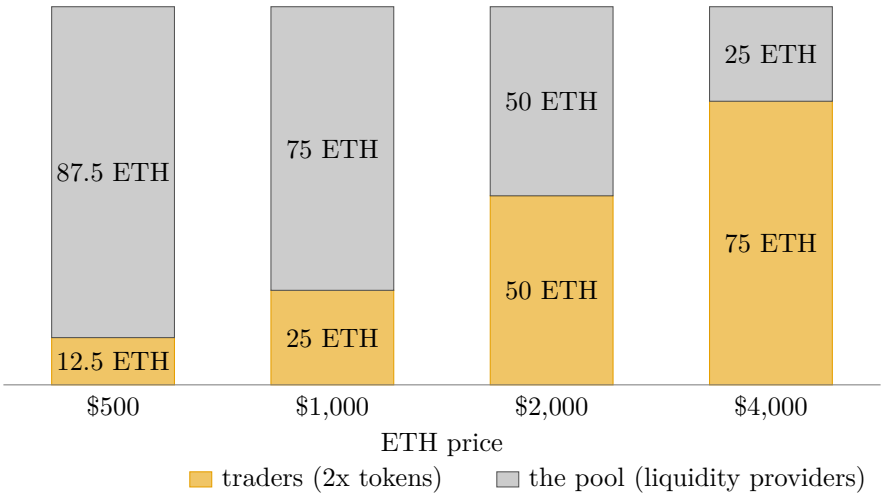


Figure 3: The same reserve as bars, showing the ETH each side owns at four prices, out of the 100 ETH in the reserve. As the price rises, ETH moves from the pool to the traders. As it falls, the ETH moves back.

On big moves the multiplications build on each other. If the price of ETH is multiplied by ten in a pool with the headroom for such a rise, the value of the 2x token is multiplied by 100 (the headroom of this example ends at $2,000, Section 4). If the price halves, the token keeps 25% of its value. On the way up it gains more than a plain doubling of the move, and on the way down it loses less than a plain doubling would.

The rule is a fixed function of the price. Know the price, and you know how much of the reserve each side owns. To hold the multiple, the contracts buy and sell no ETH at all, and a zigzag leaves them no trades to lose money on. That is why the Decayless column of Table 1 is back at its starting value when ETH is.

A reader who has borrowed against a position will ask about the crash, the moment a lender sells. Here the ETH behind your token is already in the pot, and no loan put it there. There is no lender to repay and no ETH that has to be sold. When ETH falls, the share of the pot behind your token shrinks smoothly, and the position has no trigger price at which it gets closed.

That does not make the token safe. A 2x token loses most of its value in a deep fall, and if the price of ETH went to zero, all leverage tokens would be worth zero. The difference is that you can't be closed out at the bottom and miss the recovery.

What this means for a holder

Your token is a share of ETH that's already in the reserve. Before fees, and as long as the pool has headroom, its value at any moment depends only on the price of ETH at that moment, whatever route the price took to get there. The next section explains headroom.

4 Why full leverage has a limit

Go back to the pool in Table 2. As ETH rises from $1,000 to $2,000, the pool hands ETH to the traders. But each ETH it keeps is worth more, and its dollar value still grows, from $75,000 to $93,750 to $100,000. At $2,000 that growth stops.

Suppose the full-2x rule carried on to $2,200. The traders would need 55 ETH, which would leave the pool 45 ETH, worth $99,000, less than the $100,000 it had at $2,000. From that price on, paying the traders a full 2x would start to shrink the dollars in the pool. We chose not to allow that. We protect the dollar value of the pool, so that a rise in ETH does not cost the liquidity providers dollars, and the leverage of the traders gives way instead.

We call $2,000 the *headroom limit* of this example, and the distance to it from the price today, +100%, its *headroom*. The limit is where the full-2x rule stops, and the pool is far from empty when ETH gets there. It still holds 50 ETH.

Above $2,000 the dollar value of the pool stays at $100,000. Any further dollar the reserve gains as ETH rises goes to the traders. So the traders keep gaining, but no longer at 2x.

To see what that does to you, follow $1,000 of the 2x tokens in the example through Table 3. That's a share of the traders' side, one ETH of its 25 at the price today. Up to the limit it's worth what a full 2x pays. At $3,000, a full 2x would be worth $9,000 and your token is worth $8,000. At $4,000, it's worth $12,000 instead of $16,000.

Up to the limit, a small further rise in ETH moves your token twice as far. We call that multiple, measured on a small further move, the *effective leverage* of the token, and it is exactly 2 up to the limit. Past the limit it slides down toward 1. At $3,000 it is 1.5, which means a further 1% rise in ETH lifts the token by about 1.5%, and at $4,000 it is 1.33 (Figure 4).

A token in this state is *compressing*. Its effective leverage stays above 1, so from any point on, the token still rises faster than ETH itself, just less than twice as fast. That is the whole story for a token that has the pool to itself. In a pool with several tokens, every token but the gentlest reaches a price where it stops compressing and goes flat, moving with ETH from then on, and Section 5 shows where.

Table 3: $1,000 of the example's 2x tokens at six ETH prices, before fees. This is a share of the traders' side of Table 2 and isn't a new purchase. A new purchase pays a fee and moves the limit slightly (Section 6). Up to $2,000 the token is worth exactly what a full 2x pays. Past it, the token is worth less, at the effective leverage shown. "ETH behind your token" counts the same position in ETH. It keeps growing as the price rises, more slowly past the limit.

ETH price ($)	Your token ($)	A full 2x ($)	ETH behind your token	Effective leverage
500	250	250	0.50	2.00
1,000	1,000	1,000	1.00	2.00
1,500	2,250	2,250	1.50	2.00
2,000	4,000	4,000	2.00	2.00
3,000	8,000	9,000	2.67	1.50
4,000	12,000	16,000	3.00	1.33

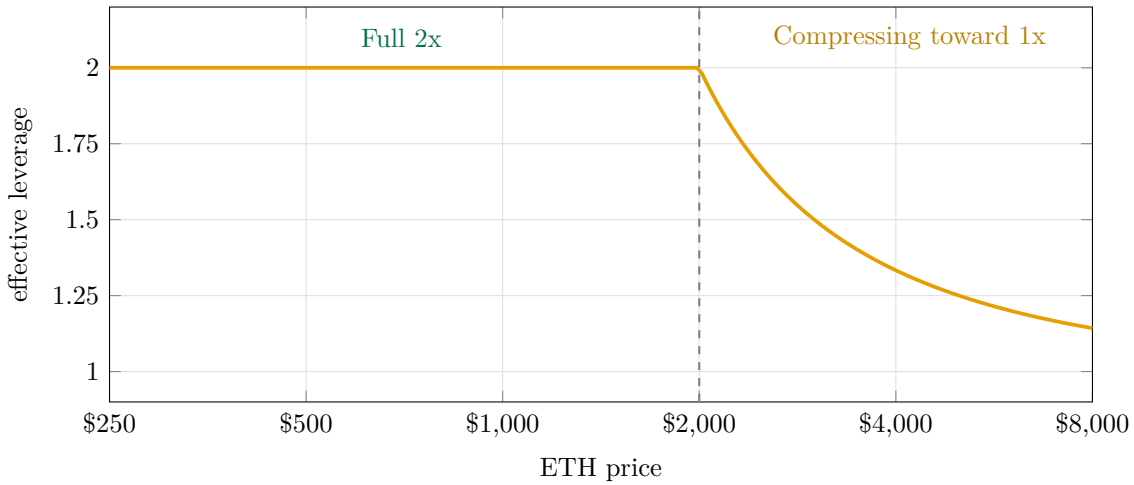


Figure 4: Effective leverage of the example's 2x token as ETH's price moves. It is exactly 2 up to the headroom limit at $2,000 (dashed line) and slides toward 1 beyond it, without a jump anywhere.

Compressing can sound like a liquidation in slow motion. It isn't a sale, a forced close or a liquidation. As the price rises the token gives up no ETH, and the ETH behind it keeps growing, more slowly than before (the fourth column of Table 3).

Nor is anything locked in. Between trades, the split between the two sides is a fixed function of the price. So if ETH runs past the limit and then comes back below it with no one trading in between, the token is worth what a full 2x is worth at that price, as if the trip had never happened.

A trade made while the token is compressing changes that. The reserve then restarts the full-2x rule of the token from its compressed value. Once ETH is back below the limit the token again moves at a full 2x, but its value need not be what it would have been without the trip.

Falls do not use up headroom. A falling price can't take a token past its limit, and the catch is about large gains.

But the limit can be close. How close depends on how much the pool holds compared with the tokens it backs. In the four-token example of Section 5, for instance, the 3x token starts compressing after a rise of just +23%.

You can see where you stand before you trade. The app shows the headroom of each token next to the trade, in two parts. The first is a number: how much further ETH can rise before that token stops delivering its full multiple, counting the trade you're about to make. The second is a dot with a word, "Full 2x" or "Compressing".

Headroom grows when liquidity providers deposit, and in this example it shrinks when traders open more leverage against the same pool, your own trade included. With several tokens in one pool it usually shrinks too, and Section 5 describes when it does not.

What this means for a holder

Full leverage while the pool has headroom. If price runs past the pool's headroom, your leverage compresses; it never liquidates. Compressing means you keep gaining as ETH rises, but by less than your multiple. As soon as ETH is back below the limit, you're back at your full multiple. Check the gauge before you open: its number is how far ETH can rise before your token stops being a full 2x.

5 How one pool backs four tokens

So far the reserve has backed a single token, the 2x. A real pool backs four tokens on the same ETH, all filled by the same liquidity providers: 1.25x, 1.5x, 2x and 3x. They follow their own versions of the rule from Section 3.

Table 4 shows how they react to a move in ETH while they have headroom. On small moves a token moves roughly its plain multiple. On big moves the multiplications build on each other. When ETH doubles, for instance, the value of the 2x token is multiplied by four (two times two), and that of the 3x token by eight (two times two times two).

Table 4: What a move in ETH does to each leverage token while it has headroom. Each entry is the token's move, in percent. Small moves look like the plain multiple. On large moves a token gains more than its plain multiple on the way up and loses less than it on the way down.

ETH's move	1.25x token (%)	1.5x token (%)	2x token (%)	3x token (%)
−50%	−58.0	−64.6	−75.0	−87.5
−20%	−24.3	−28.4	−36.0	−48.8
−10%	−12.3	−14.6	−19.0	−27.1
+10%	+12.7	+15.4	+21.0	+33.1
+20%	+25.6	+31.5	+44.0	+72.8
+50%	+66.0	+83.7	+125.0	+237.5
+100%	+137.8	+182.8	+300.0	+700.0

For the numbers we borrow the example of the short paper. Suppose the four tokens own one tenth of the ETH in the reserve apiece today, and the pool owns the other six tenths.

In this example the pool reaches its own limit after ETH rises just +23%. Past that point it can't keep all four tokens at their full multiple, and one of them has to give way first. The design settles which with a queue, ordered by leverage:

1. The 3x token goes first. It compresses on its own, and the other three keep their full multiple.
2. While it compresses, the 3x token receives the ETH the pool releases beyond what the other three need for their full multiple. That leftover shrinks as the price rises. When it reaches zero, the 3x token could give way further only by handing over ETH it already holds, and the queue takes no ETH from a token on a rise. So the token goes *flat*. It keeps the ETH it holds and from then on simply moves with ETH, like holding ETH itself.
3. Next the 2x token compresses, and later goes flat. Then the 1.5x does the same.
4. The 1.25x token is last. It never goes flat and just compresses toward 1x, the way the single 2x of Section 4 does.

As the price rises, a token in the queue loses no ETH, which means the queue makes no sales along the way. And when the price falls back, the whole queue runs backwards.

So the queue gives each token its own limit (Figure 5). The 3x token keeps its full multiple until ETH has risen +23%, the 2x until +105%, the 1.5x until +343%, and the 1.25x until +1216%. The gentler the token, the further the price can run, and the gauge in the app shows the number for each token.

Each token but the 1.25x also has a second price, where it goes flat, and the queue puts it at the limit of the next gentler token. The 3x token compresses from +23% until ETH stands at 2.047 times today's price, where it goes flat and the 2x token starts to compress. The 2x goes flat at 4.429 times today's price, where the 1.5x takes over, and the 1.5x at 13.161 times, where the 1.25x takes over and compresses from then on. Figure 5 shows the stages of each token.

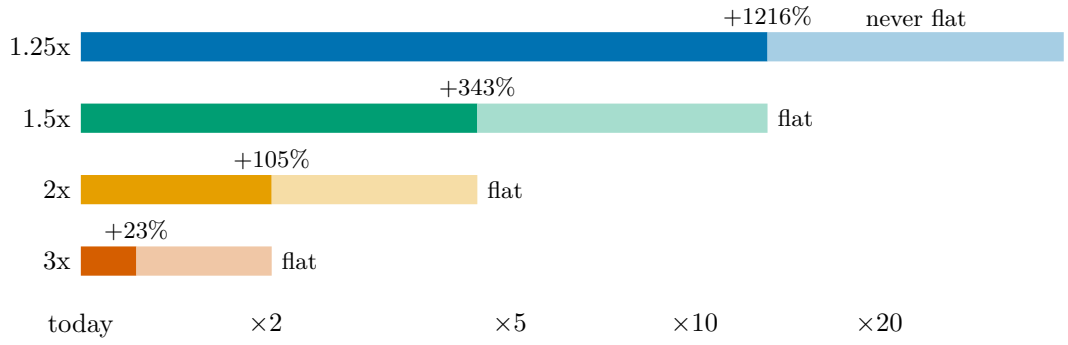


Figure 5: The stages of each token in the four-token example. The solid bar runs from today's price to the token's limit, labelled with the rise ETH would need to get there. The pale bar is the stretch over which the token compresses, and it ends where the token goes flat, at the limit of the next gentler token. The 1.25x token compresses from its limit on and never goes flat.

We put the aggressive tokens first in the queue because they draw hardest on the pool. To keep a 3x token at its full multiple, the pool has to release ETH 8 times as fast as it would for a 1.25x token of the same size.

The full paper proves that this order gives the gentlest token the most ETH at every price, then the next gentlest, and so on. The 3x token pays for that. In a big rally it ends up with less ETH than it would if all four tokens shared the shortfall equally.

The order also matters for whose trades move your headroom. Say you hold one of the gentler tokens, and someone opens a large 3x position while the pool is already stretched. Your headroom doesn't go down. It even goes up slightly, because half of the fee they pay is added to the pool. A trade made while the pool still has headroom is different, and it moves the limit of every token a little.

The queue protects the gentle tokens from the aggressive ones, but it doesn't protect them from liquidity leaving. When liquidity providers withdraw, everyone's headroom falls.

6 What does a position cost?

One fee, covering entry and exit; nothing while you hold. The fee is charged at one rate, on the way in on what goes into your position and on the way out on what comes out. While you hold the position, you pay no funding, management fee or rebalancing cost. The higher the leverage, the higher the fee, and Table 5 gives the launch schedule.

Suppose you pay $1,000 to open a 2x position. Of that, $909 goes into your position and $91 is the fee. That's 10% of the $909, or 9.09% of the $1,000 you paid. So the rate is charged on the amount that goes into your position, and as a share of everything you pay it is a little lower, which is why the table shows both. Half of the fee, about $45, is added to the pool as ETH for the liquidity providers. The other half leaves the reserve for the protocol's auctions, which the protocol's own documents describe.

Now say you closed again at the same price of ETH. The fee on the way out would take the same share of what leaves your position, and you would get back $826. A round trip at an unchanged price therefore costs about 17% of what you paid, and holding longer adds no further cost.

Your own trade also moves the limit. A new position is new leverage the pool has to back, so opening one uses up some headroom, a little more than the half of the fee that goes to the pool

Table 5: Launch fees. One fee covers entry and exit, charged on the way in on what goes into the position and on the way out on what comes out. The last column is the same fee as a share of everything you pay.

Token	Fee rate (%)	Share of what you pay (%)
1.25x	2.50	2.44
1.5x	5.00	4.76
2x	10.00	9.09
3x	20.00	16.67

gives back. In the example of Section 4, opening this $1,000 position moves the limit of the 2x token from $2,000 to about $1,948. That's why the gauge in the app counts the trade you're about to make.

The fee grows with the leverage because the higher multiples draw harder on the pool. A 3x token draws on it 8 times as hard as a 1.25x token of the same size (Section 5), and its fee rate is 8 times as high, 20.00% against 2.50%. The pool gets paid the same for each unit of backing it provides, whichever token uses it.

You don't have to pay in ETH. You can pay in dollars (a stablecoin, a token designed to stay worth one dollar), and you can take either ETH or dollars back when you close. If you pay in dollars, the app swaps them for ETH in the same transaction. That swap has its own cost, called price impact, and the app shows it before you confirm.

7 The liquidity providers on the other side

Suppose you take the other side instead. You deposit ETH into a pool (or dollars, which are swapped for you) and receive LP tokens, your share of it. You back all four leverage tokens of that pool at once, and you can't pick one. From the block after your deposit (the blockchain's next batch of transactions), you can withdraw at any time, in ETH or in dollars.

In return you earn fees. Half of every fee, on the way in and on the way out, is added to the pool as ETH the moment it is paid, so the share of the reserve behind an LP token grows with each trade. This is payment for taking the other side, in proportion to how much traders open and close. It is variable fee income, not a fixed yield, and a quiet pool earns no fees. Liquidity providers also get rewards in the protocol's own token, DCL, from the auctions that the other half of the fees feeds. The protocol's own documents specify those, and we don't count them here.

But the pool is the counterparty of the traders, and its ETH moves the opposite way to theirs. Table 6 follows the pool of the single-2x example (75 ETH, worth $75,000 today). It compares the pool with two things its owners could have done instead. They could have kept the 75 ETH, or kept the $75,000 in dollars.

- When ETH falls, the traders' ETH flows to the pool. At $500 the pool holds 87.5 ETH, worth $43,750. That's more than the $37,500 the 75 ETH would be worth, but less than the $75,000 kept in dollars.
- When ETH rises, the pool hands ETH to the traders. Up to the limit, its dollar value still grows, reaching $100,000 at $2,000. Past the limit the value stays at $100,000, while the ETH the pool holds keeps shrinking. At $4,000 the pool holds 25 ETH, and someone who had simply kept the 75 ETH would have $300,000. The higher ETH goes, the less ETH the pool holds, and there's no floor.

So at any price the pool sits between the two alternatives, never better than both and never worse than both, with the fees on top.

Which of the two to compare against is your choice, since you can deposit and withdraw in either asset. With four tokens instead of one the numbers change, but the shape stays the same, as the short paper shows.

Table 6: The pool of the single-2x example at six ETH prices, compared with keeping the same 75 ETH or keeping $75,000. The figures are before fees, which the pool earns on top. In each row the pool's value lies between the last two columns.

ETH price ($)	Pool's ETH	Pool's value ($)	Kept the ETH ($)	Kept the dollars ($)
500	87.5	43,750	37,500	75,000
1,000	75.0	75,000	75,000	75,000
1,500	62.5	93,750	112,500	75,000
2,000	50.0	100,000	150,000	75,000
3,000	33.3	100,000	225,000	75,000
4,000	25.0	100,000	300,000	75,000

What this means for a liquidity provider

Backing higher leverage means bigger swings in your balance. A rally or a crash changes what your LP tokens are worth, but neither can liquidate them.

8 Fair prices between traders

Suppose the price of ETH stays the same while you open and close as often as you like, in any leverage tokens and in any order, hoping to find a sequence that makes money. However you do it, you end up having paid the fees, no more and no less. The full paper proves this and checks it on 2,400 random sequences, including some that cross a headroom limit halfway through.

Other people's trades are the next worry. A trade by anyone else, in any token, leaves the value of your leverage token where it was at the price that trade used. It can still change your headroom, in the ways Section 5 describes.

Liquidity providers are the exception, in their favour. Half of the fee on a leverage-token trade is added to the pool, so each such trade raises the value of the pool a little.

The reserve also keeps no record of how it got where it is. After each trade, the contracts work out the rule afresh from the ETH that each leverage token and the pool hold at the price of that trade. So two reserves in which each token and the pool hold the same ETH at the same price are the same reserve, and they behave the same from then on. That is how a trade by someone else can move your headroom while it leaves the value of your token at its price where it was. The trade changes the amounts the rule is rebuilt from.

All of this rests on the price the contracts use. They read it from a price feed built on Uniswap, a large exchange that runs on the blockchain, and the feed gives two readings. One is an average of the last half hour, which is allowed to move only slowly. The other is the price the exchange showed at the start of the current second, which no trade made in that second can change. A trade always gets whichever reading is worse for the person trading, so you buy at the higher one and sell at the lower one.

A reading can lag the real market, and a trader who knows the market has moved would like to trade at the stale price. Under this rule they get no better price from the pool than the slow average would give, and usually a worse one. The same holds for someone who pushes the price on the exchange around: their own trade still gets no better price than the slow average.

The gap between the two readings is an extra cost, paid to the people already in the pool. At a gap of 0.5% between the readings, for example, opening and closing a 2x position costs about 0.50% more, and when the readings agree the extra cost is zero.

The full paper also proves a limit on trading back and forth at the two readings. Take a trader who starts and ends with nothing open, trades while the two readings stay the same, and has no one else trading in between. Fees aside, such a trader ends with no more than they started with, and one who holds leverage tokens alone also loses at least the fees. The one case the paper checks numerically instead of proving is a trader who also holds a share of the pool and pays fees. Trades by other people in between are outside the proof.

Everything else here assumes the feed is right. A manipulated or lagging price would move all the positions in the pool at once, which is why deep, heavily traded markets are safer.

9 Limits and risks

The main promise comes with its condition attached. Full leverage while the pool has headroom. If price runs past the pool's headroom, your leverage compresses; it never liquidates. The list below collects what else the design does not promise.

- **No decay depends on headroom.** Inside its headroom, the value of a token depends only on the price of ETH, whatever route the price took and whatever anyone else does. Past its limit, the token keeps gaining at a smaller multiple. All the tokens but the 1.25x eventually just move with ETH. If the price comes back, the token gets its full multiple back. The app shows the headroom of each token next to the trade.
- **A leverage token can lose most or all of its value.** Leverage works both ways. Suppose the price of ETH halves: a 2x token keeps a quarter of its value, and a 3x token keeps an eighth. If the price of ETH went to zero, all the leverage tokens would be worth zero. There's no liquidation, but there's no floor either.
- **The fees are real.** At an unchanged price, a round trip in the 2x token costs about 17% of what you paid. It costs more in the 3x and less in the 1.25x. Holding longer adds no cost, so the fee weighs most on short holds.
- **Liquidity providers can lose.** Compared with holding ETH, a large rally past the limit of the pool leaves the pool with less and less ETH, and there's no floor. Compared with holding dollars, a crash costs them. The fees are their payment for that, in proportion to trading. They vary with trading and aren't a fixed yield.
- **One timing trick is narrowed but not removed.** A liquidity provider might join the pool just before a very large fee is paid and leave just after. New deposits have to wait one block (the blockchain's next batch of transactions) before they share in fees or can leave. That removes the risk-free version of the trick. A one-block gamble on a single very large fee is still possible, and the app splits very large trades to make it unattractive. The short paper describes it.
- **The price feed is trusted.** Everything said here is about the reserve at the prices the feed reports. The two readings of the feed (Section 8) can both be behind the market at once, for as long as the exchange hasn't traded, or longer after a market halt. Giving you the worse of the two narrows that window, but it doesn't remove it. The protections of the feed itself belong to the protocol, and we don't re-derive them here.
- **The proofs use exact arithmetic.** Real contracts round numbers. The full paper lists what the code has to get right, and we make no claim here about the code of any particular deployment.
- **The protocol token and the auctions are described elsewhere.** Half of each fee goes to the protocol's auctions. The protocol's own documents specify how that half is used.

- **Bets on a fall use a mirror-image market.** A token that gains when ETH falls comes from the other side of the pair, a market whose reserve holds dollars (USDC) and measures their price in ETH. That market has its own reserve, pool and headroom. It works just as described here, with the roles of ETH and dollars swapped, so its multiples are counted in ETH. A design in which such tokens share one pool with the ETH tokens isn't part of the launch. The full paper proves it would work, but it isn't used.

10 Words we use

ETH
The currency of the Ethereum blockchain, and the asset in all the examples here.

Leverage, 2x
Moving a multiple of a price's move. For small moves, a 2x position moves about twice as much as the price.

Leverage token
A token that is a share of the traders' part of a reserve, at a fixed leverage of 1.25x, 1.5x, 2x or 3x. Its name on the blockchain gives the asset, the dollar coin it's priced in and the multiple, so WETH-USDC-2X is ETH at 2x, priced in USDC. WETH is ETH in the wrapped form that smart contracts use.

Market
One asset at one leverage, ETH 2x for example.

Reserve
The pot of ETH behind one asset's leverage tokens, split between the tokens and the pool.

Pool
The liquidity providers' part of the reserve. It is the other side of each leverage token.

Liquidity provider (LP), LP token
Someone who deposits into the pool. An LP token is their share of it.

Smart contract
A program that runs on a blockchain and holds money according to its code.

Liquidation
The forced sale of a borrowed position after a price fall. Decayless has no liquidations.

Funding
A payment that the two sides of a perpetual futures contract settle every few hours, which keeps the price of the contract near the price of the asset. A holder can pay it or receive it, and a bet on a rise usually pays it when many traders want to make the same bet. Decayless charges no funding.

Decay
The loss a daily-rebalancing leveraged token suffers when the price zigzags. A Decayless token has no decay while it has headroom.

Headroom
How much further ETH can rise before a token stops delivering its full multiple. The app shows it live, counting the trade being made. It grows when liquidity providers deposit and usually shrinks when traders open more leverage.

Headroom limit
The price at which a token's headroom is used up.

Effective leverage
The multiple a token is actually delivering right now. It is the full multiple inside the token's headroom, sliding toward 1 past its limit.

Compressing, flat
Compressing means that past its limit, a token still gains as ETH rises, by a shrinking multiple.

Flat means that, at the price where it would otherwise start losing ETH, a token (any but the 1.25x) stops at a fixed amount of ETH and from then on moves with ETH.

Fee

One fee, covering entry and exit; nothing while you hold. It is charged on the way in on what goes in and on the way out on what comes out. Half goes to the pool and half to the protocol's auctions.

Where to go next. The short paper covers the same design in more depth, and works through the four-token example in full. The full paper has the mathematics behind both. It marks each result as proved, checked by a script, or still open, and its verification scripts recompute all the numbers in the three papers in a few seconds. If you doubt a number, you can change the example and see what moves.

Acknowledgments

The design, its proofs and the papers that describe it were developed through an adversarial review in which two large language models acted as counterparties, Claude Fable 5.1 by Anthropic and Codex by OpenAI. One side proposed and proved, the other tried to refute, and both checked each claim the design rests on numerically. The verification scripts are part of the papers and are the author's responsibility, as are any errors that remain.