Deep Freeze – A DeFi Patience Primitive

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Intro

Deep Freeze is an in-development protocol for storing long-term holdings within a user generated smart contract. These "freezers" serve as on-chain cold storage. Users can (but are not required to) add a custom password-hash pair to protect these long term holdings. If they get hacked, their wallet will get drained by the hackers, but ownership of the freezer can be safely transferred to a new wallet, protecting their long term holdings, by using the password-hash (and a private transaction to prevent front-running by the hackers).

This is a great solution for those who dislike the poor UX of hardware wallets, but don't want to trust a custodian like Coinbase with their assets or juggle multiple accounts.

But what if you want to protect your long term holdings while also generating yield?

Currently, you can trust your assets to a smart contract that pays *extrinsic* yield, such as AAVE which generates yield from collateralized borrowing of assets. AAVE then gives you a derivative version of your asset (e.g., deposit ETH and get AAVE's aETH) and you can put that derivative token in long term storage. It's value (in ETH terms) will grow over time at some variable rate.

Extrinsic yield = external risk & effort

This works now, many do it, but it does expose you to a few types of risk.

(1) The ever-present smart contract risk.

There could be a bug in the code and the protocol gets hacked. Although for a blue chip like AAVE, this risk is very low and they're trusted with billions of dollars of assets accordingly.

(2) Risk to yield.

Yield generating protocols are actively managed. Many use upgradeable proxy contracts. As they release new upgraded versions of their offerings, the market will react. If you have your assets in AAVE V2 (released 12/2020), as they launch AAVE V3 (released 11/2021) the market will shift to using V3. AAVE V2 depositors will generate less yield, and many will migrate accordingly. This exposes you to the headache of also migrating or exposes you to potential issues with AAVE doing the migration for you (see: upgradeable proxy contracts and (1)).

Again, AAVE is a blue chip DeFi protocol trusted with billions of dollars. It's probably one of the safest places in all of DeFi to store assets. This is not an attack on AAVE, the writers of this paper are active AAVE users and fans of the protocol. The point is **extrinsic yield** has risks that make them less suitable for long term holdings (e.g., multi-year)- not only smart contract risks (which can be minimized) but also risk to yield that requires the user to *do something* (e.g., migrate).

Deep Freeze solves this problem using a game theory approach that tokenizes patience. The more patient you are, the more you can earn. You earn it all upfront. What you do with your yield is up to you. The yield is *intrinsic*. But the *value* of that yield, is market determined- are you more patient than the average investor? Are you more patient than the market as a whole?

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Deep Freeze enables a market for tokenized patience itself

Alice has 100 ETH. She doesn't really need 100 ETH in her hot wallet, she can probably get by with 10 ETH in her everyday account(s) and 90 ETH in long term storage. She considers herself very patient and wants to try out Deep Freeze.

She goes to the Deep Freeze site and creates a Freezer with a 90 ETH deposit. She goes ahead and adds a password-hash to protect it as well (this is optional). She goes to an online keccak hash calculator (you can play with one here, go ahead type some words and see the hash) and gives the freezer the hash:

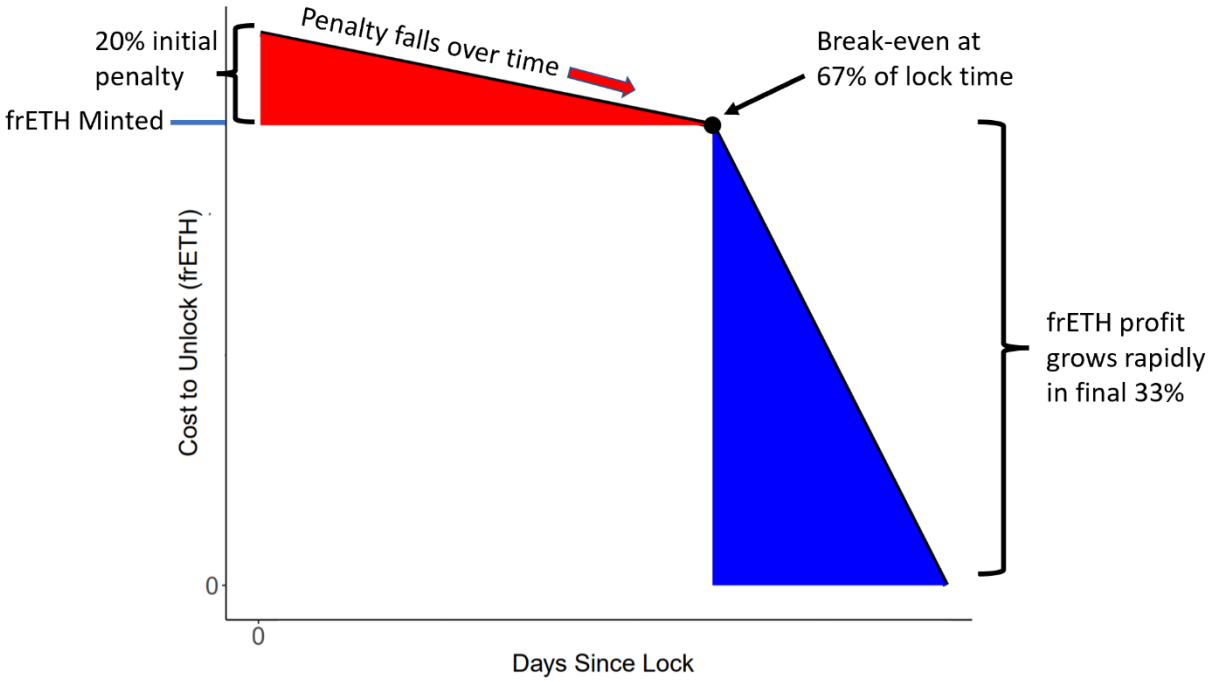
ee42aa7ea02389608005edf2e64e2b0f425680c27835914d855f036b61f24b58

She safely writes down the English phrase that generates this hash when passed to *any* Keccak-256 calculator (including the one that is built into Ethereum). Even if you hack Alice, you aren't going to get her 90 ETH unless you can figure out what words in the English language hash to that value. Good luck, quantum computers have not broken Keccak-256 yet.

Her long term assets are safe behind (1) freezer ownership (only the owner can withdraw) and (2) the English phrase that generates the hash she provided.

Now Alice needs to decide- how patient is she?

Deep Freeze enables her to lock her ETH for any desired amount of time and get the "freezer" version of her asset as yield – ETH generates frETH. This yield is intrinsic and paid upfront. But it's still a *gamble* on her own patience because early withdrawals are penalized.



Strategies

Alice has a few strategies to consider:

Strategy	Action	Gain	Risk
The Degen	Lock 90 ETH for Max Time Sell new frETH for new ETH Lock new ETH for Max Time ... Repeat until gas cost becomes prohibitive.	Maximum instant yield all in ETH.	Fully exposed to frETH market volatility for any early withdrawals. May need to sell freezers OTC at a discount if frETH gets too expensive.
The Guru	Lock 90 ETH for Max Time Sell new frETH for ETH Enjoy the yield, wait patiently.	Instant yield in ETH	Fully exposed to frETH market volatility for early withdrawal. Withdrawal expensive.
The Hedger	Lock 90 ETH across multiple freezers for rolling amounts of time. Manage a balance of frETH alongside ETH.	Instant yield, some in frETH, some in ETH.	Partially exposed to frETH market but has both a stash of frETH and strategically cheaper freezers.
The Timid	Deposit 90 ETH, don't lock, or lock for very small amounts of time. Accrue a buffer of frETH. Only lock when she has enough frETH to early withdrawal.	Small bits of yield, nearly all in frETH.	Minimum exposure to frETH market. Avoids risk of not being able to withdraw early. Earn little yield.

Alice likes things simple and isn't a fan of leverage, her risk profile most aligns to The Guru strategy. She decides to lock her 90 ETH for 3 years. She receives (90 * 3 years) = 270 frETH.

Her lock is initiated with a 20% penalty on Day 0. Her break-even day is 67% of her lock time, here, 2 years later, or Day 730, where the cost is the same as her initial yield (270 frETH). At the end of her lock time, 3 years later, or Day 1095, she has earned all her yield and it costs 0 frETH to unlock.

Minted	Day 0 Withdraw Cost	Day 365 Withdraw Cost	Day 730 Withdraw Cost	Day 912 Withdraw Cost	Day 1095 Withdraw Cost
270 frETH	324 frETH	297 frETH	270 frETH	135 frETH	0 frETH

Her early withdrawal cost depends on if she is before or after her break-even day. It is a simple linear function of her progress toward either the breakeven day or her final day (whichever hasn't happened yet). The penalty decreases slowly until the breakeven day, afterwards, her profit rises extremely quickly. This is to maximize the incentive of waiting the entire lock period.

Since 365 is halfway to the breakeven day; her penalty (originally 20%) is halfway reduced (10%) – she would pay 297 frETH to withdraw early. After her breakeven day (Day 730), her profit grows extremely quickly. Day 912, being halfway between 730 and 1095, would mean she is halfway into her profit, i.e., she's earned half of her original 270 frETH and would only pay 135 frETH to withdraw early.

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Freezer Asset Tokenomics

1. There is no fixed supply

Patient people create supply.
Impatient people burn supply.

frETH is created when someone deposits ETH, which removes ETH from the circulating supply. 1 frETH = [1 ETH removed from the market for 1 year]. The amount of frETH in the market is directly proportional to the amount of ETH currently locked **and previously earned** in freezers. How should it be valued?

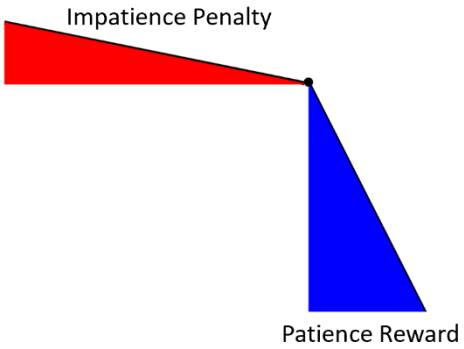
2. The value of frETH is partially determined by internal factors

frETH's internal value is the opportunity cost someone who has locked ETH gives up by not having ETH readily available. As a baseline comparison, the frETH value may be similar to the net present value of 1 year of yield from staking ETH after the proof of stake merge (e.g., Lido staked ETH's APR discounted to receiving the yield upfront).

Long Term 1 frETH could be ≈ 0.02 – 0.04 ETH
Short term, it'll be much more volatile!

Similar to how new ETH issuance should hypothetically dilute existing ETH's value by increasing supply, users who successfully wait for their freezers to unlock are increasing the supply of frETH.

EIP-1559 created a burn mechanism to manage new ETH issuance (including issuance possibly being smaller than ETH burned) – the "ultrasound money" meme. Similarly, the *penalty* mechanism of frETH (i.e., withdrawing early) also removes frETH from supply. Just like EIP-1559 makes the supply of ETH change as a function of use, the penalty mechanism makes the supply of frETH change as a function of the market's changing patience.



The fundamental question becomes which will be bigger?

The total market penalties for impatience (red), or the total rewards for patience (blue)? This determines the supply flow of frETH.

3. The value of frETH is partially determined by external factors

When Alice locks her ETH in a freezer to earn frETH, she has reasons to keep the frETH (just in case she needs to withdraw early) and reasons to sell the frETH (get a different asset, even ETH again!). These push and pull incentives are affected by the broader market. When ETH's price grows (and maybe even becomes short-term overpriced), she'll feel pressure to withdraw early, pay the penalty, and sell her ETH (so she can buy more ETH later when the price falls). When ETH's price drops (and maybe even becomes short-term underpriced), she'll feel less pressure to withdraw early, and may even feel she can deposit more ETH to get more frETH!

With thousands of people going through these feelings in parallel, frETH's price will be volatile. Some will withdraw early and some will double down. But even people without a Deep Freeze freezer can benefit from frETH.

Remember, 1 frETH = [1 ETH removed from the market for 1 year]. Who benefits when ETH is removed from the market for 1 year? All holders of ETH benefit! Reducing the available supply of ETH, puts upward pressure on the price of ETH.

Bob has 20 ETH and $4000 USDC. If ETH is $4,000, he can buy 1 ETH, taking 1 ETH off the market for as long as he wants and putting a small upward pressure on ETH's price. If frETH is 0.02 ETH; he could instead buy 50 frETH. Remember what a frETH is:

1 frETH = [1 ETH removed from market for 1 year]

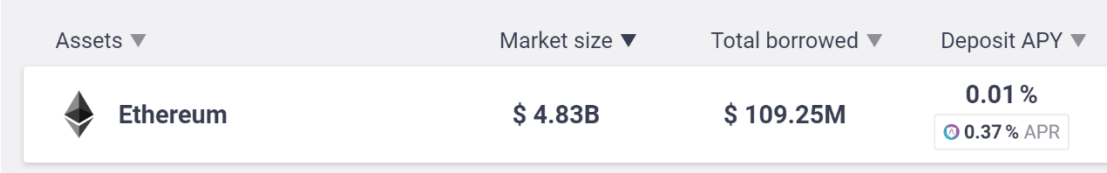
Bob buying 50 frETH is equivalent to paying to remove 50 ETH from the market for 1 year. This directly increases the cost for Alice to withdraw early and indirectly puts upward pressure on the price of ETH.

Now of course, there's no guarantee that 50 frETH grows in value the way 1 ETH might grow in value. But it's the kind of game theory that brings investors that want to manipulate short term supply, gamble on the aggregate of people's individual patience (will Alice withdraw early and sell?), and profit from high volume trading between pairs of assets (here, frETH / ETH).

In summary, Deep Freeze creates a pure free market for tokenized *patience* itself. Non-users of Deep Freeze can engage in this market, hoard frETH to increase the cost of impatience (early withdrawal) and profit both directly from trading frETH and indirectly by reducing the supply of ETH available in other markets- similar to how staked ETH is expected to reduce the circulating supply of ETH.

4. <u>There is a market for even the *lowest yield* if it is also *lowest risk*</u>

When pitching Deep Freeze, we heard 2 things repeatedly: First, why isn't the ETH locked in freezers deposited to earn yield- i.e., why don't freezers "double dip" in both extrinsic and intrinsic yield? This misunderstands the problem statement and the fundamental theory of finance- maximizing *risk adjusted* returns. Deep Freeze is targeting the *very large* market for truly minimized risk storage of assets. Don't believe us?



Here is a screenshot of mainnet AAVE's ETH deposits. Nearly $5,000,000,000 worth of ETH effectively earning 0% interest (that 0.01% may not even cover gas costs on mainnet). This is just a fraction of the total addressable market (TAM) of Deep Freeze. Every blockchain native asset held "raw" is addressable market for Deep Freeze and its purely intrinsic yield.

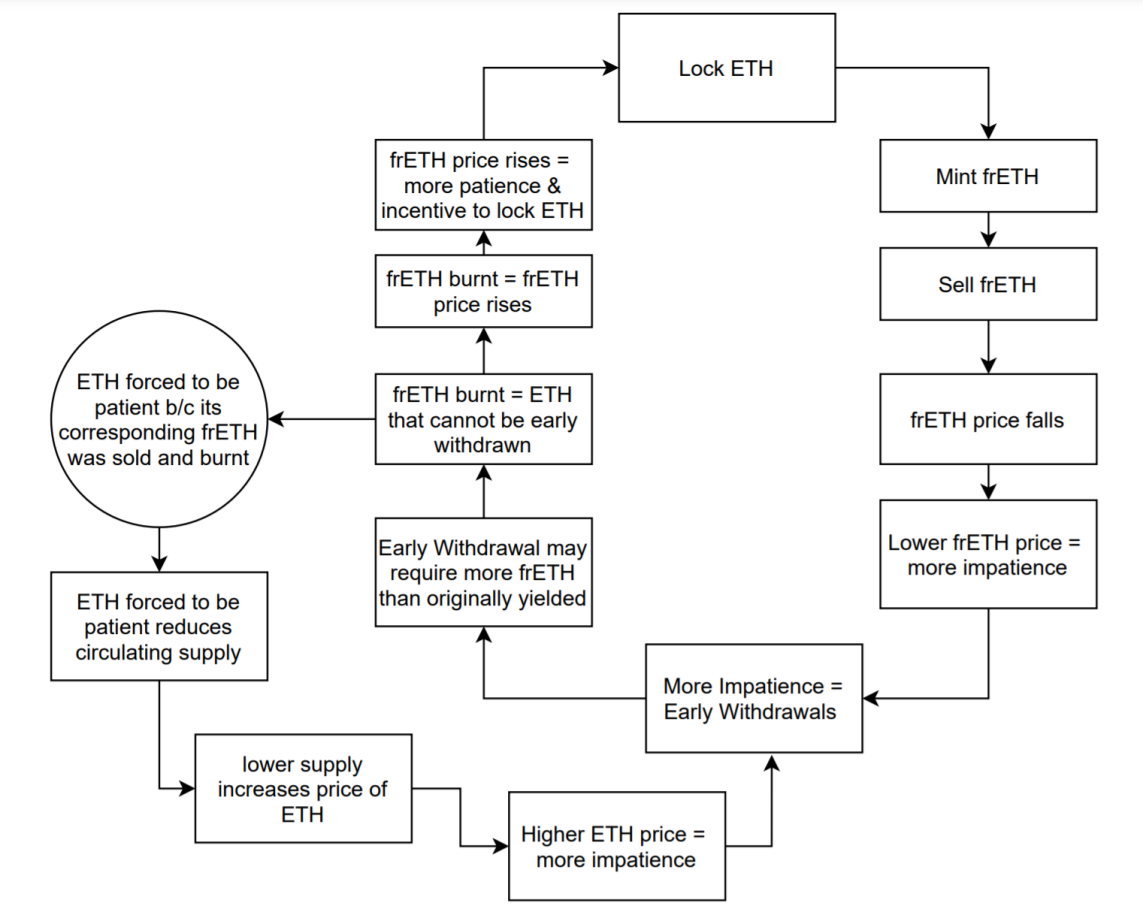
5. <u>frETH dumping means ETH pumping – a natural equilibrium exists</u>

The second thing we heard repeatedly was: what happens if everyone does The Degen strategy and dumps frETH and leverages up on ETH?

The price of frETH plummets, that's what happens! But remember:

1 frETH = [1 ETH removed from market for 1 year]

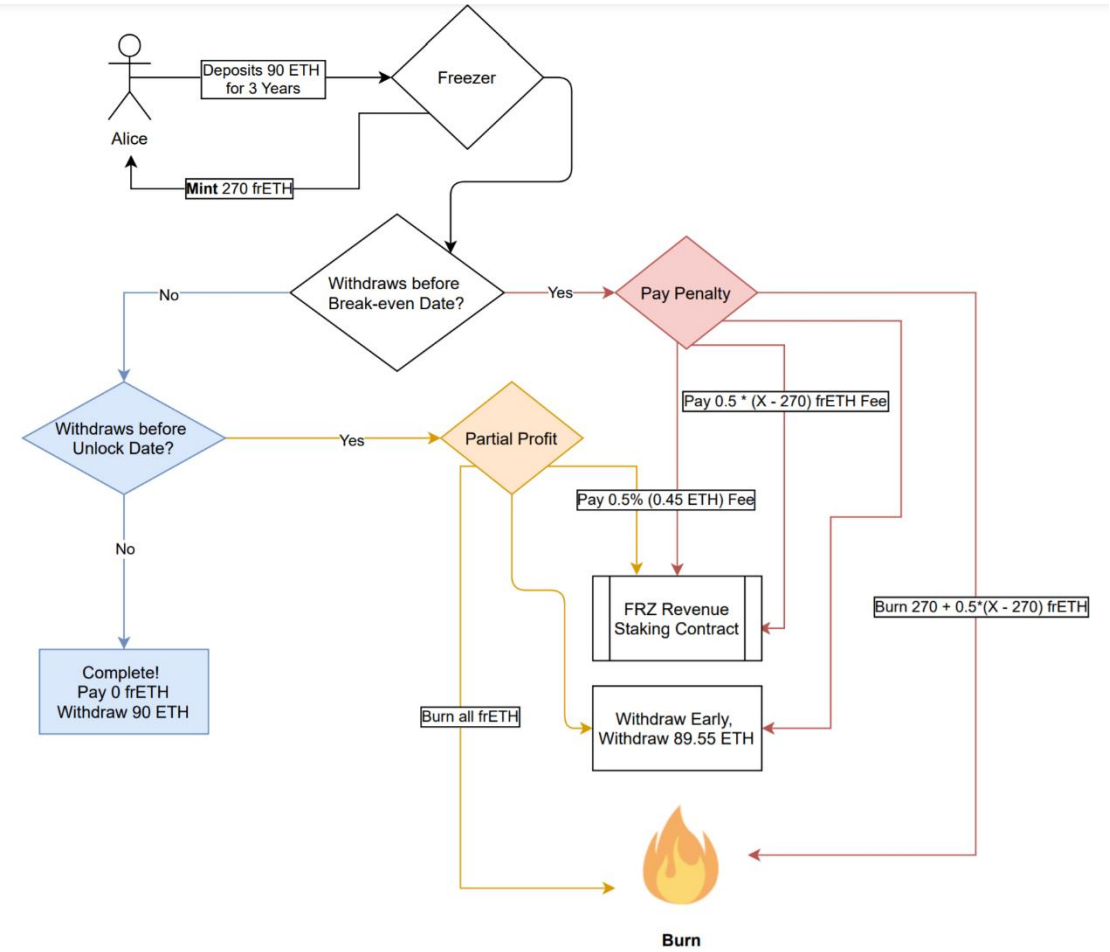
This will never change – it is the essence of how frETH is valued (and why we've written it 4 times in 3 pages). To get a better understanding of how a natural equilibrium will be found (as a function of the market's reaction to changing prices of patience), review this diagram:



The cheaper the frETH, the cheaper impatience. The cheaper impatience, the more early withdrawals we'll see. Early withdrawals that pay penalties burn frETH. Burnt frETH forces a corresponding amount of ETH to be patient. This ETH that is forced to be patient reduces circulating supply, which puts upward pressure on the price of ETH. Higher priced ETH also incentivizes early withdrawals. This causes a feedback loop of more frETH burnt to withdraw ETH early. All this burnt frETH increases the price of frETH, which incentivizes more patience and more locking of ETH to create more frETH. A natural equilibrium is found between these counteracting forces. Long term, frETH becomes a volatility absorber for ETH itself.

Revenue / Governance

Deep Freeze will be a 0 governance, 0 administrative protocol. It will be immutable upon launch with a fixed fee structure to generate revenue for FRZ stakers. A diagram of Alice's deposit is included here:



Stakers of the FRZ token will receive 2 forms of revenue.

1. frETH penalties

The frETH penalty for withdrawals (up to 20%) is frETH taken out of the market- it only exists because someone has locked ETH and made their frETH available for purchase. Half of this frETH penalty (half the amount above frETH minted originally) is paid to stakers of the Deep Freeze revenue token FRZ. The other half is burned, offering a small deflationary pressure to offset frETH minting inflation.

Although penalty frETH is burned, frETH will likely still be net inflationary.

2. ETH withdrawals

To further incentivize patience, a small 0.25% fee is applied to **all** early withdrawals and paid to directly to stakers of FRZ. This is binary, only completed lock cycles (and of course, deposits that never decide to lock to get frETH) avoid the fee.

Simulations Across Patience Profiles

A simulation analysis was developed to understand potential frETH supply flows caused by different patience profiles. The full report is available here on CharlieDAO website, included here is a review of the 5 different baseline assumptions for vault users, their behaviors, and the resulting supply of frETH and fee revenue for FRZ stakers.

# Vaults in Simulation	# ETH Deposited	# frETH Minted	Weighted Avg. Deposit Time
10,000	89,980	168,203	1.87

Patience Profile:	Extreme Impatience	Moderate Impatience	Balanced	Moderate Patience	Extreme Patience
% Withdraw Early	85	50	25	15	5
% Breakeven	5	20	25	15	5
% Almost Complete	5	15	25	20	5
% Complete	5	15	25	50	85
Simulation Results					
frETH Penalty Paid	14,246	8,257	4,199	2,595	852
frETH Burned	7,123	4,128	2,100	1,297	426
frETH Supply	161,080	164,074	166,103	166,905	167,776
frETH Supply / ETH Deposited	1.79	1.832	1.846	1.85	1.86
frETH Supply / frETH Minted	95.7%	97.5%	98.7%	99.2%	99.7%
ETH Fees Paid	212	192	167	111	34
ETH Fees / ETH Deposited	0.23%	0.21%	0.18%	0.12%	0.04%
Market Impatience “Discount Rate”	4.2%	2.4%	1.24%	0.8%	0.25%

The simulation report goes into more specifics on how to interpret these metrics and our opinion on which is these is most realistic (hint- markets are impatient and bots/algorithm traders will find plenty of profit in the correlated frETH and ETH markets to pay for early withdrawals strategically). Overall, the key interpretations are:

1. frETH burned is ETH that is **forced to be patient**. This has a direct implication on the circulating supply of ETH. The typically 24HR daily volume of ETH is 3M of ETH (~$10-15B worth). Given that bots and algorithmic traders can buy and sell the same ETH repeatedly in the same hour (let alone day), removing circulating supply will have an outsized effect on the daily volume of ETH.

2. ETH fees paid as a percent of ETH deposited is analogous to AMM trading fees on most patience profiles (0.23% in extreme impatience), which makes the Tokenomics of the FRZ token more realistic.

3. Because frETH is burned during early withdrawals, the relationship of 1 frETH = [1 ETH removed from the market for 1 Year] is actually the *ceiling* price of removing ETH from circulating supply. The more impatient the market, the lower the frETH Supply / frETH Minted. Using (1 – frETH Supply/frETH Minted) to calculate Market Impatience as a "discount rate", shows that the more impatient the market, the cheaper it is to remove ETH from circulating supply. For Extreme Impatience, there is a 4.2% discount on removing ETH from supply.

This Market Impatience "Discount Rate" is the tokenization of patience, it is captured within the frETH token. We should expect (long-term) that the relative value of frETH (in ETH terms) is roughly fluctuating around this discount rate. For an impatient market, frETH should be expensive (because many people want to unlock early), for extreme impatience, it should be roughly 4.2% of ETH's price (0.042 ETH). In a patient market where frETH is plentiful (e.g., the Extreme Patience 0.25% discount rate), we may see frETH at roughly 0.0025 ETH.

Relative to AAVE's 0.01% deposit yield, an extremely patient market is still **magnitudes of order** higher intrinsic yield.

This is the power of intrinsic yield. Allow people to gamble on their patience, and when they are wrong (or when it suits them to exit early for other short-term opportunities) that value accrues to the patient via FrETH burn.

Next Steps

In Q1 2022 CharlieDAO is launching Deep Freeze V0 on its own website prior to spinning it out into a distinct entity and monetizing. Once spun-out, Deep Freeze full intrinsic yield features will be developed and tested. A formal launch of Deep Freeze V1 and the FRZ token will follow.

To speed up development, 20% of FRZ is anticipated to be allocated to the core team and early funders. If this project interests you as a developer and/or funder, please reach out to discuss more!