

Post-Shanghai LSDs and Bank Run Risks

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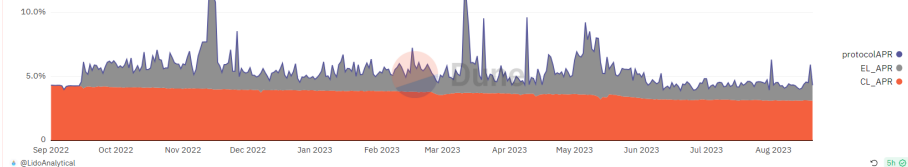
History of Ethereum Staking

- The Merge (Sep 2022): Ethereum migrated from PoW to PoS
⇒ Now anyone can stake 32Ξ on mainnet and accrue rewards as a validator
- The Shanghai/Capella Upgrade (Apr 2023)
⇒ Introduced option to withdraw staked ETH (unstake)

Breakdown of Ethereum Staking Rewards

- Consensus layer rewards: Attestation, block proposal, sync committee
- Execution layer rewards: Txn fee (EIP-1559), MEV

Protocol APR*: Consensus Layer (CL) APR and Execution Layer (EL) APR Lido post Merge APR
Dune SQL



source: @LidoAnalytical on Dune

ETH Staking Landscape

ETH Staked

Ξ25,693,856

ETH Staked 🍷

@hildobby

11h

Percentage of Staked ETH

21.60%

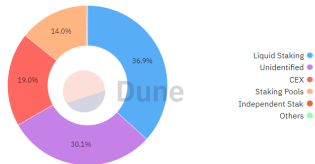
Staked Share of ETH Supply 🏠

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ETH Staked Breakdown

by Category



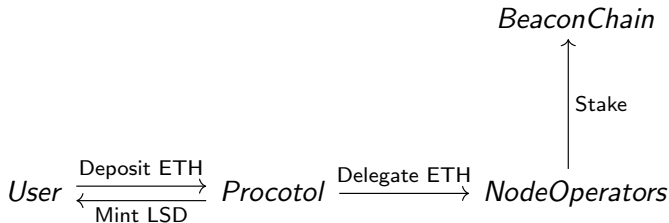
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source: @hildobby on Dune

Liquid Staking Derivatives (LSDs)

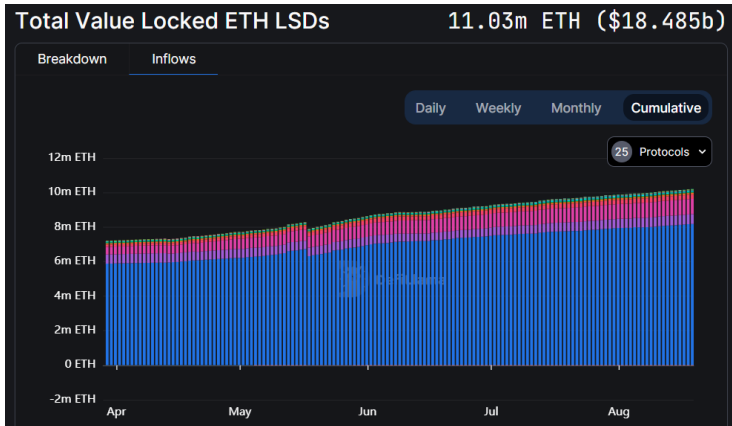
ERC-20 tokens that represent ETH tokens locked in PoS contracts.
A simplified model:



- Benefits: 1. staking rewards 2. retail-friendly 3. has liquidity
- Use cases: borrowing/lending, trading portfolio collateral, etc.
- LSDs are redeemable for ETH at any time
- Most LSDs accrue rewards automatically i.e. **holding LSDs is equivalent to staking ETH in the pool**

LSDs saw huge growth after Shapella

Currently LSDs are the #1 DeFi sector and Lido is the #1 DeFi protocol by TVL.



source: DeFi Llama

Liquid Staking Protocols as Banks

¹Banks are financial intermediaries which create liquidity by:

- Gathering liquid funds (e.g. customer deposits) as liabilities
- Holding illiquid investment projects (e.g. loans, bonds) as assets

Similarly, LSD protocols create liquidity by:

- Gathering liquid funds (ETH) as liabilities
- Holding illiquid investment projects (Ethereum staking) as assets

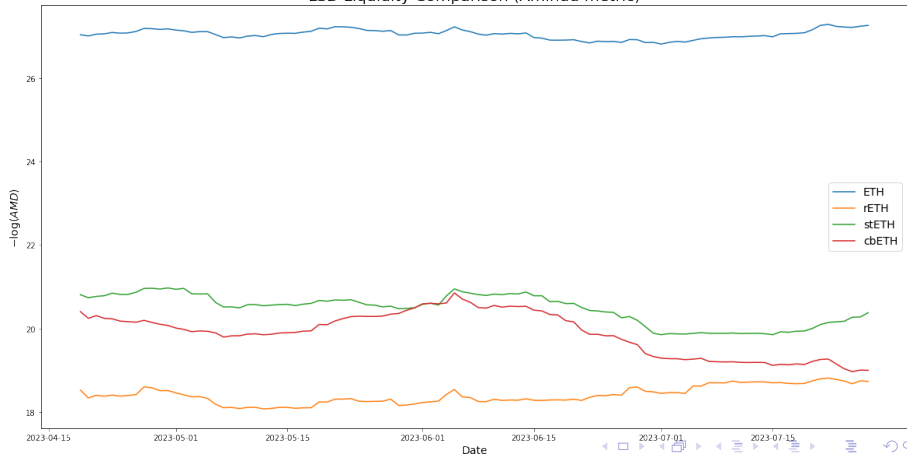
¹Diamond and Dybvig (1983) Theory of Banking

How Much Liquidity do LSDs Provide?

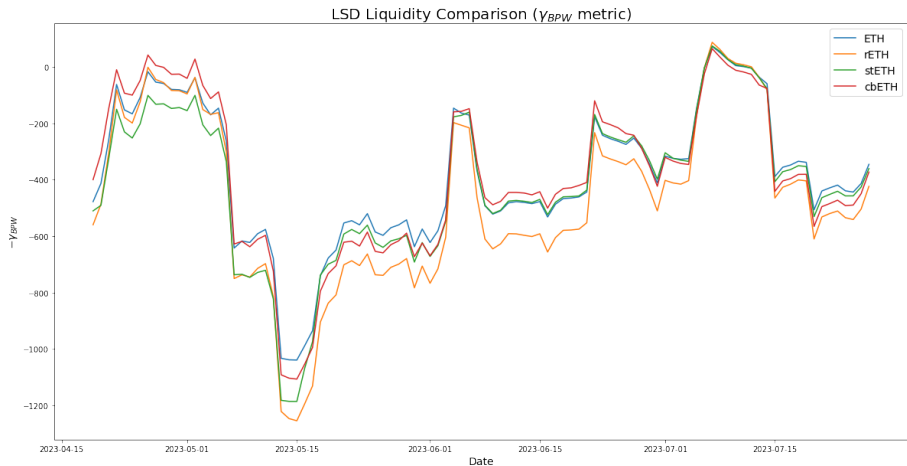
Introducing two quantitative measures of (il)liquidity:

① Amihud (2002): $AMD_{id} = \frac{1}{N_{id}} \sum_{t=1}^{N_{id}} \frac{|r_{it}|}{V_t}$

LSD Liquidity Comparison (Amihud metric)



② Bao, Pan, and Wang (2011): $\gamma_i = -\text{Cov}(\Delta p_{it}, \Delta p_{it-1})$



Are LSD Bank Runs Possible?

Bank runs are typically triggered by 1. sudden increase in demand for liquidity 2. expectation of protocol insolvency.

- Liquidity shortage: e.g. CRV exploit July 2023 where multiple liquidity pools were drained
- ETH price drop
- Regulatory crackdown: e.g. SEC deems LSDs as securities
- Large-scale slashing or penalty of validators
- Bugs/exploits/hacks stealing protocol funds

During a LSD Bank Run


Two main methods of converting LSDs back to ETH:

- Direct redemption from protocol
- Through DEXes

What happens after these run out?

Withdrawing Staked ETH from Validators

- Step 1: Exit queue – only 10 validators can exit per epoch (≈ 2225 validators or 0.5% circulating supply per day).
- Step 2: Withdrawal queue – same queue with partial withdrawals but is processed much slower

VALIDATOR SET OVERVIEW ⓘ	
METRIC	VALUE
Active validators	744,777  +2,014 validators
Activation queue length ⓘ	24d 19h 54m 59,921 validators
Exit queue length ⓘ	32m 8 validators
Withdrawal queue length ⓘ	7d 7h 55m 37,737.3 ETH

Last resort

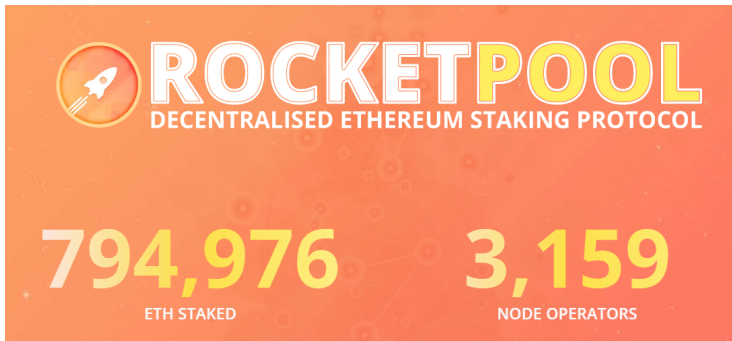
- Pause/delay withdrawals (e.g. Lido's Bunker Mode)
- Sell protocol equity (e.g. gov tokens) !! Might cause self-fulfilling prophecy of insolvency!!

Systemic Risks

- Centralization of stake (esp. Lido): Nethermind Research and Lido are collaborating to solve this²! Also DVT
- APR drop from excessive staking (block rewards do not scale linearly with ETH staked)
- ETH supply inflation if staking \gg usage (ETH minted \gg burned by EIP-1559)

²See “A Path to Permissionless Liquid Staking” by Nethermind & LidoDAO

Rocket Pool (rETH)



Rocket Pool is the 3rd largest LSD protocol by TVL and the largest **permissionless** LSD protocol.

rETH Liquidity Analysis

(Data as of Aug 26, 2023)

Balancer v2 rETH-WETH pool	12,893Ξ
Balancer v2 rETH-wstETH-sfrxETH pool	11,307Ξ
Curve v2 rETH-ETH pool	2,238Ξ
Uniswap v3 rETH-ETH pool	1,007Ξ
Total DEX Liquidity	27,445Ξ
Protocol Owned Liquidity (Deposit Pool)	18,000Ξ
Total Liquidity	45,445Ξ

This is only 5% of rETH supply issued (902,768Ξ), or 4% if not counting other LSDs as liquidity.

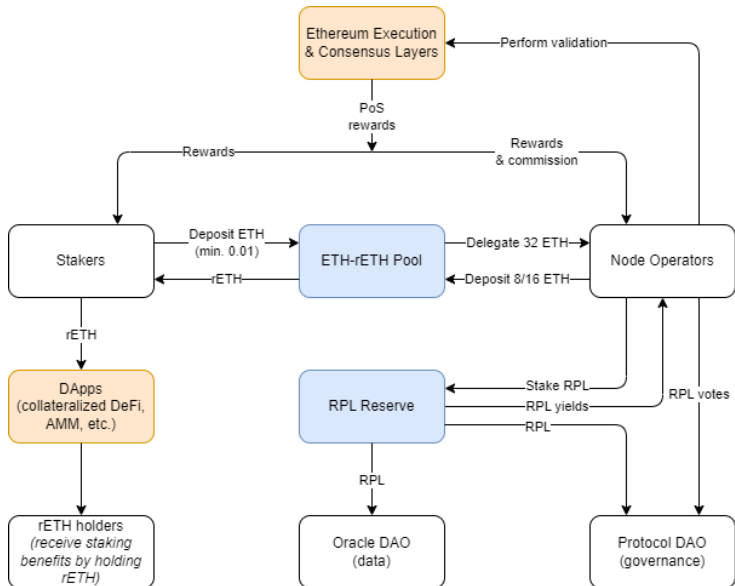
v.s. US banks 10% reserve requirement + Fed loans available

Rocket Pool Agent-Based Model & Simulation

Together with Joel Kahil at Nethermind, I've been building an agent-based simulation model for Rocket Pool to study and improve their protocol design. We focus on:

- rETH and RPL tokenomics
- Behavior of node operators
- Response to external shocks
- Bank run simulation

We plan to use the model to evaluate several proposed changes in RPL's tokenomics by the protocol DAO. Stay tuned for more updates!



Thank You!

Twitter/Telegram: @MingXDynasty

I'm on the job market for 2024!

References I

- Amihud, Y. (2002). Illiquidity and stock returns: Cross-section and time-series effects. *Journal of financial markets*, 5(1), 31–56.
- Bao, J., Pan, J., & Wang, J. (2011). The illiquidity of corporate bonds. *The Journal of Finance*, 66(3), 911–946.
- Diamond, D. W. (2007). Banks and liquidity creation: A simple exposition of the diamond-dybvig model. *FRB Richmond Economic Quarterly*, 93(2), 189–200.
- Diamond, D. W., & Dybvig, P. H. (1983). Bank runs, deposit insurance, and liquidity. *Journal of political economy*, 91(3), 401–419.
- Nethermind.eth. (2023a). Ethereum withdrawals and liquid staking. <https://medium.com/nethermind-eth/ethereum-withdrawals-and-liquid-staking-68f0d50bbb81>

References II

Nethermind.eth. (2023b). The liquid staking rush.

<https://medium.com/nethermind-eth/the-liquid-staking-rush-1977aef2bad0>

Nethermind.eth. (2023c). A path to permissionless liquid staking.

<https://medium.com/nethermind-eth/a-path-to-permissionless-liquid-staking-9934557f6d20>