

What's at Stake? Competition in Crypto Staking

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Motivation: Role of Staking

- Proof-of-Stake (PoS) emerged as the main alternative to the PoW consensus mechanism to secure transactions in blockchain networks
- Validators create new blocks and validate transactions on the ledger
- Validators with larger stakes have a higher probability to be selected
- Validators earn rewards for their work and share them with their delegators
- Token holders (delegators) select a small number of trusted parties (validators) by staking their tokens

This Paper

- How efficient is the staking market?
 - How do delegators choose validators? How do validators set fees?
 - Capital allocation has implications for the efficient provision of validation services: Can more efficient validators enter? Do inefficient ones get penalized?
- Validators act as intermediaries. Many parallels to the mutual fund and money market fund industries
- Big picture question for financial intermediation
 - Pricing strategies and equilibrium outcomes in the presence of returns to scale and investor inertia

Why Cardano?

- One of the oldest and largest PoS blockchains
- Active delegation market: 5K validators and 1.6M delegators
- Unlike Ethereum and Solana, all data are recorded on the blockchain
- Rich setting
 - Built-in increasing and decreasing returns to scale
 - Observe individual delegator behavior not only aggregate flows
 - Several protocol changes serve as exogenous shocks to the system

Main Results

- Delegators on average choose validators who offer higher returns, but there is heterogeneity in return-sensitivity of delegators
 - Larger delegators tend to switch validators more frequently
 - There are active and “sleepy” delegators
- Validators set fees taking into account delegator composition and differences in scale economies
 - Larger validators who benefit from increasing returns to scale charge higher fees
 - Validators with a higher share of sleepy delegators charge higher fees
 - Speed with which validators respond to exogenous protocol changes depends on their fraction of sleepy investors

Roadmap

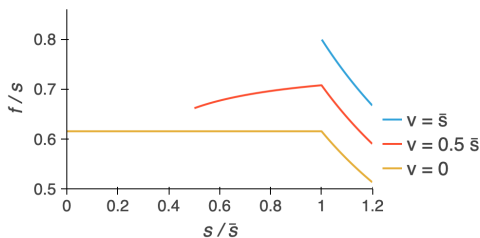
- How rewards are determined and shared between delegators and validators
- How delegators choose validators
- How validators set their fees

Validator Reward

$$R_{it} = \underbrace{R_t}_{\text{aggregate reward}} \times \underbrace{f(S_{it}, v_{it})}_{\text{adjusted stake}} \times \underbrace{q_{it}}_{\text{quality}}$$

- Validator's reward depends on
 1. Validator's total stake (s)
 2. Validator's own stakes (v)
 3. Validator's block production quality (q)
- Validator's quality is not directly observed but can be estimated

Validator Reward (Cont.)



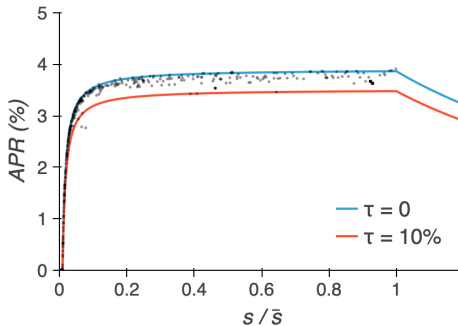
- Rewards increase in total stake up to a cap ($\bar{s} = \$34M$)
- The validator's stake gets a higher reward than a delegator's stake
- Validators with a total stake above the cap earn a lower reward per unit of stake (decreasing returns to scale)

Delegator Rewards

- Validators charge a mandatory fixed fee (c) and a discretionary margin fee (τ), and distribute the rest to delegators
- For each dollar staked, delegators receive

$$\frac{(1 - \tau_{it})(R_{it} - c)}{S_{it}} = (1 - \tau_{it}) \left(R_t q_{it} \frac{f(S_{it}, v_{it})}{S_{it}} - \frac{c}{S_{it}} \right)$$

Delegator Rewards (Cont.)

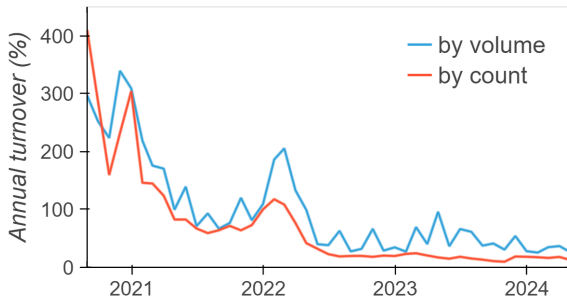


- Delegators' return is hump-shaped in total stake

Delegators

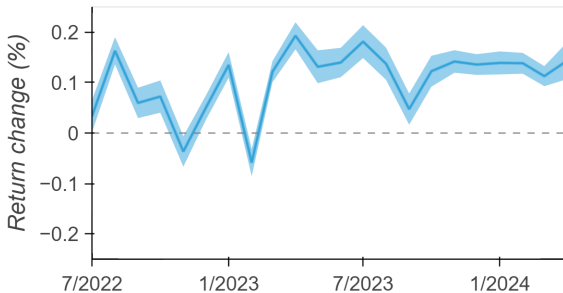
Delegator Mobility (1)

- Each year, 20% of delegators, who hold 50% of the staked capital, switch their validators



Delegator Mobility (2)

- Delegators on average choose validators who offer higher returns



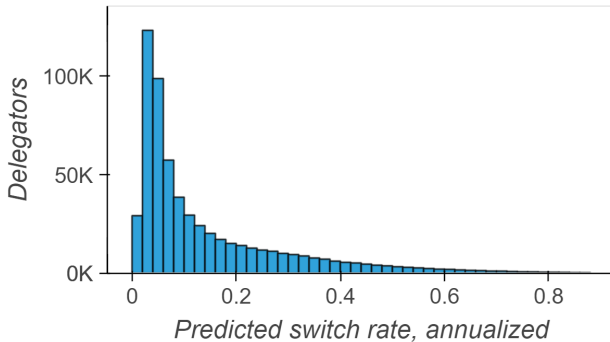
Determinants of Delegator Mobility

- Delegators are more likely to switch validators if
 - they have a larger stake
 - they have switched before
 - their current stake is with a low expected return validator

	Full sample	First half	Second half
log(stake)	0.171*** (0.001)	0.178*** (0.001)	0.185*** (0.001)
Age on chain	-0.082*** (0.000)	-0.107*** (0.000)	-0.075*** (0.000)
Switched before	1.291*** (0.003)	1.259*** (0.004)	1.427*** (0.005)
Return shortfall	28.805*** (0.116)	24.234*** (0.140)	39.311*** (0.205)
Intercept	-4.305*** (0.008)	-4.257*** (0.009)	-5.479*** (0.013)
Time FE	✓	✓	✓
N	22118771	8263542	13855229
Pseudo R ²	0.141	0.101	0.117

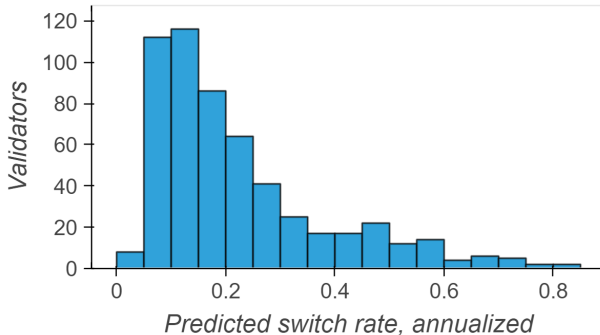
Active vs Sleepy Delegators

- Delegators are heterogeneous in their switching rate



Active vs Sleepy Delegators Across Validators

- Heterogeneity in the switching rate of delegators is also observed at the validator level



Validators

Validator Competition

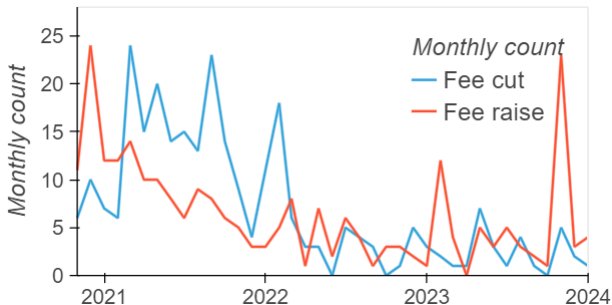
- Validators compete by setting the margin fee τ
 - Higher fee delivers a higher payoff but may drive delegators away

Hypotheses

- H1: Larger validators charge higher fees
- H2: Validators with more “sleepy” delegators charge higher fees

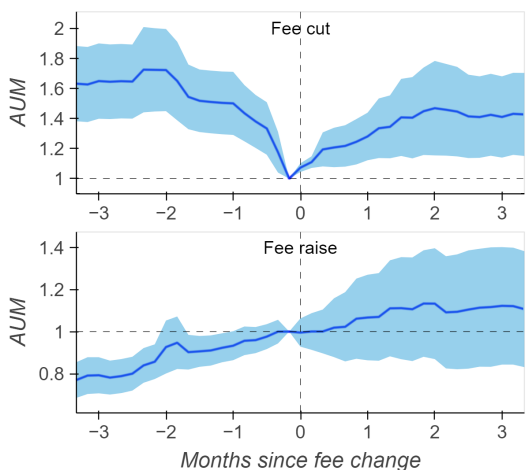
Fee Changes

- To stay competitive, validators change their fees according to the shifting market conditions



Fee Changes: Event Study

- Validators cut (raise) fees when delegators are leaving (joining)



Fees and Validator Characteristics

- Panel regression of fees on the size and predicted switch rate

$$\tau_{it} = \beta_0 + \beta_1 \widehat{sw}_{it} + \beta_2 f(s_{it}, v_{it})$$

	Full sample	First half	Second half
Predicted switch rate	-0.059*** (0.003)	-0.064*** (0.006)	-0.105*** (0.008)
Adjusted stake	6.335*** (0.248)	6.684*** (0.381)	5.299*** (0.339)
Intercept	-0.004*** (0.000)	-0.003*** (0.000)	-0.003*** (0.000)
Time FE	✓	✓	✓
R^2	0.050	0.065	0.047
N	19126	7748	11678

- Endogeneity concern: active delegators choose better validators, rather than validators exploiting sleepy delegators

How do Validators Reset Fees?

- A: validators set margin fees optimally when they change them
- Same regression but on the sample when the change happened

$$\tau_{it} = \beta_0 + \beta_1 \widehat{sw}_{it} + \beta_2 f(s_{it}, v_{it})$$

	Margin fee
Predicted switch rate	-0.0535*** (0.0159)
Adjusted stake	2.874** (1.150)
Intercept	-0.006*** (0.001)
Time FE	✓
R^2	0.044

Protocol-wide Shock to Fixed Fee

- In October 2023, all validators are allowed to set a lower **fixed** fee
- We fit the Cox's PH model on the fee reset timing
- The active delegator share strongly predicts fee reset

	Fixed fee reset propensity
	Cox Coefficient
Predicted switch rate	24.658*** (6.150)
Adjusted stake	3.451 (2.708)
Margin fee	-36.819*** (8.213)
Has changed margin	0.308* (0.186)

Conclusion

- Delegators on average choose validators who offer higher returns
- But large differences in the likelihood of switching, which is also observed at the validator level
- Validators set fees taking into account delegator composition and differences in scale economies
 - Larger validators which benefit from scale economies and validators with a higher share of “sleepy” delegators charge higher fees