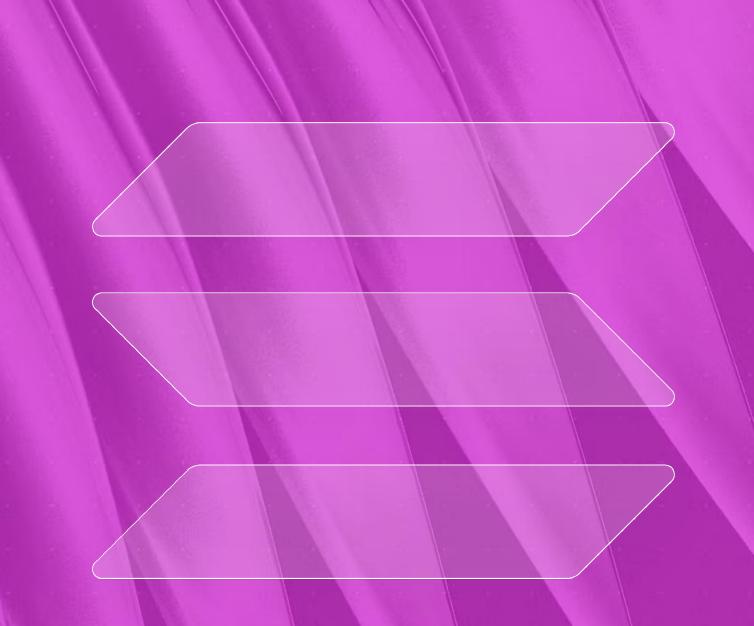
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// October 2025

Deep Dive:

Solana Onchain Activity





Part I Network



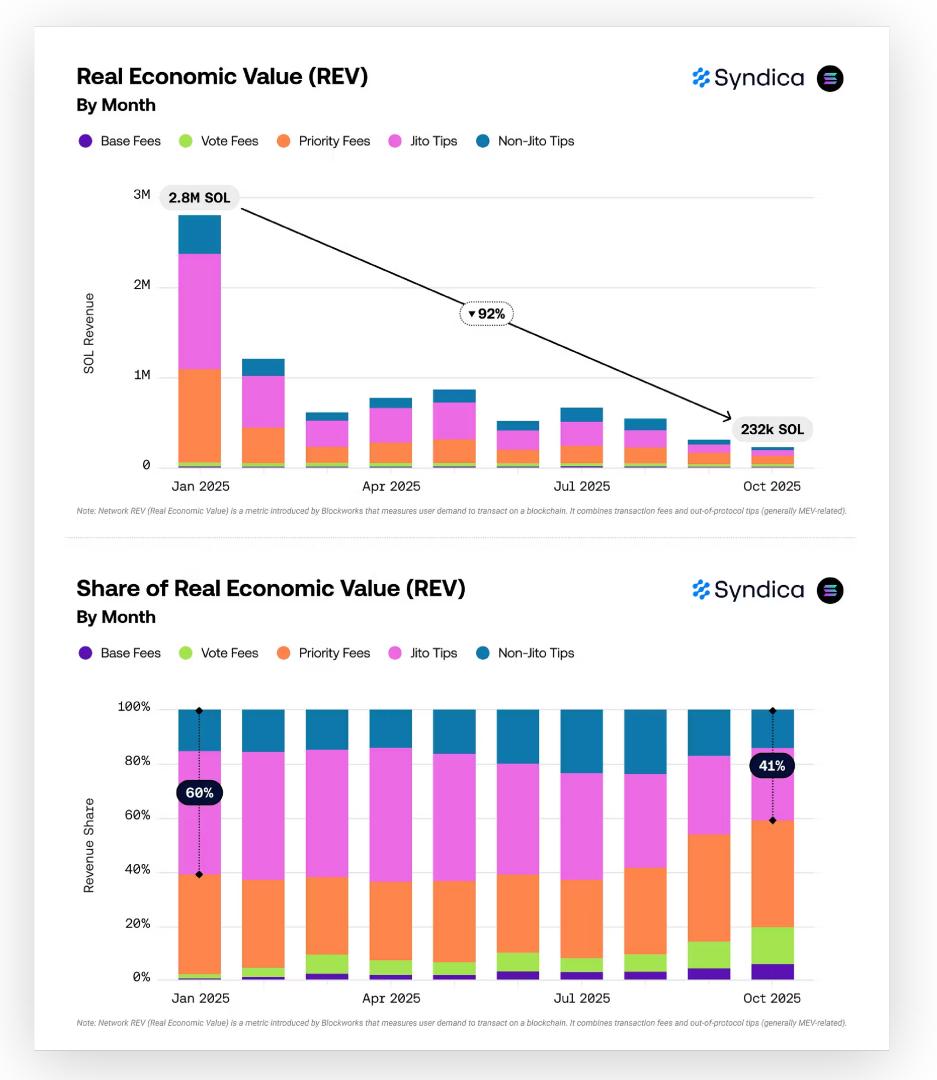
Real Economic Value dropped 92% from January to October.

REV (transaction fees and tips for transaction inclusion) dropped from 2.8M SOL in January to 232K SOL in October.

As network activity waned, tips fell from 60% to 41% of revenue.

Note: Network REV (Real Economic Value) is a metric introduced by Blockworks that measures user demand to transact on a blockchain. It combines transaction fees and out-of-protocol tips (generally MEV-related).

// Deep Dive: Network // October 2025

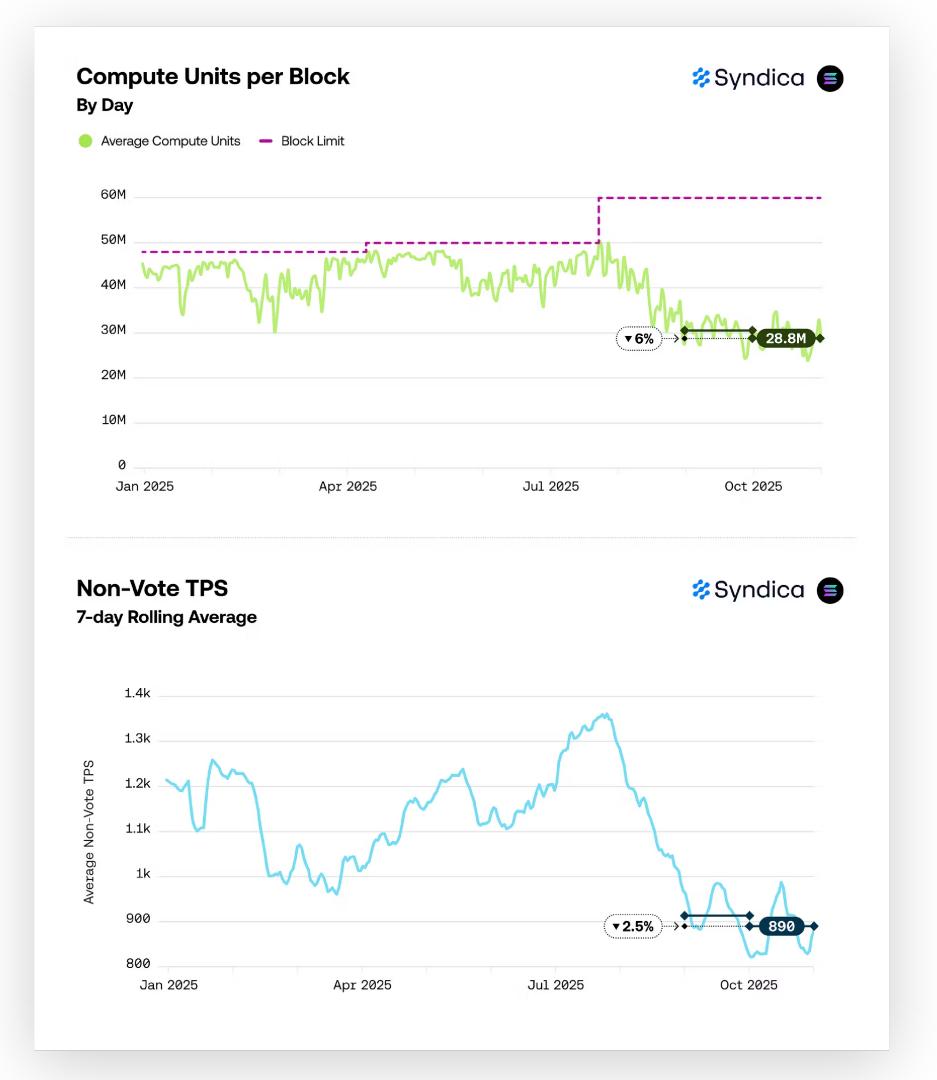




Activity metrics declined modestly to yearly lows in October.

Average compute units per block dropped 6% to 28.8M CU.

Mean non-vote TPS fell 2.5% month-overmonth to 890 transactions per second.

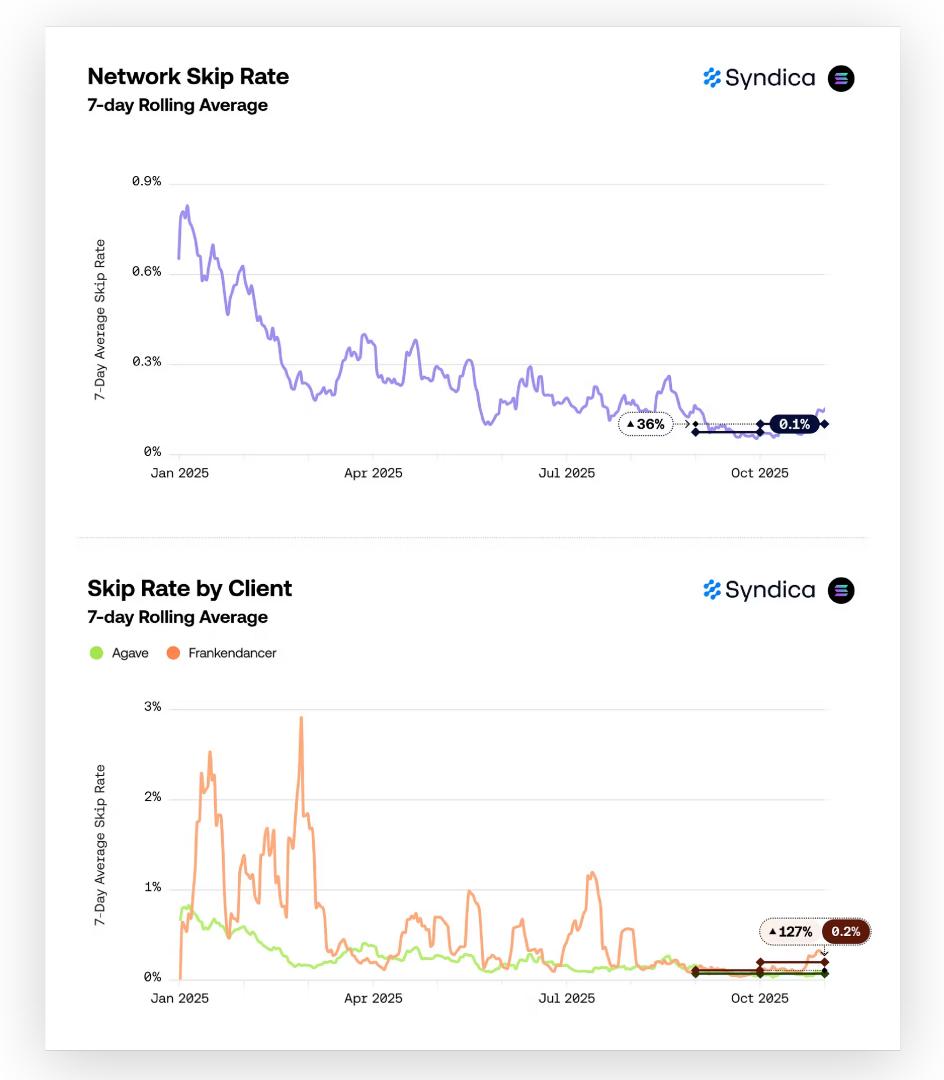




Network skip rate up 36% as Frankendancer reliability worsened.

Network skip rate reached 0.10% in October, driven by Frankendancer's skip rate more than doubling to 0.2%.

Agave's skip rate remained unchanged at 0.07%.

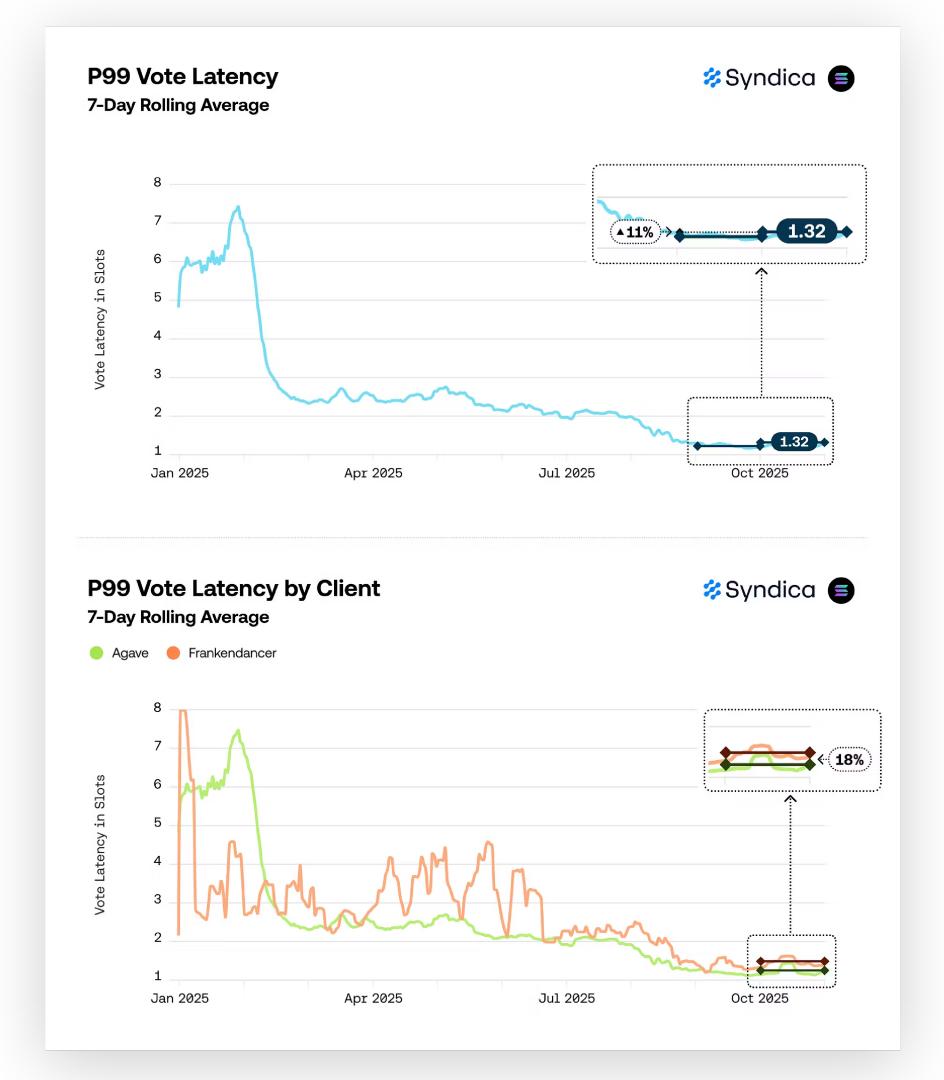




P99 vote latency rose 11% to 1.32 slots in October.

Despite the uptick, latency remained close to the ideal 1 slot target and is down 80% year-to-date.

Frankendancer validators show 18% higher p99 vote latency in October, in line with the average gap maintained since July.





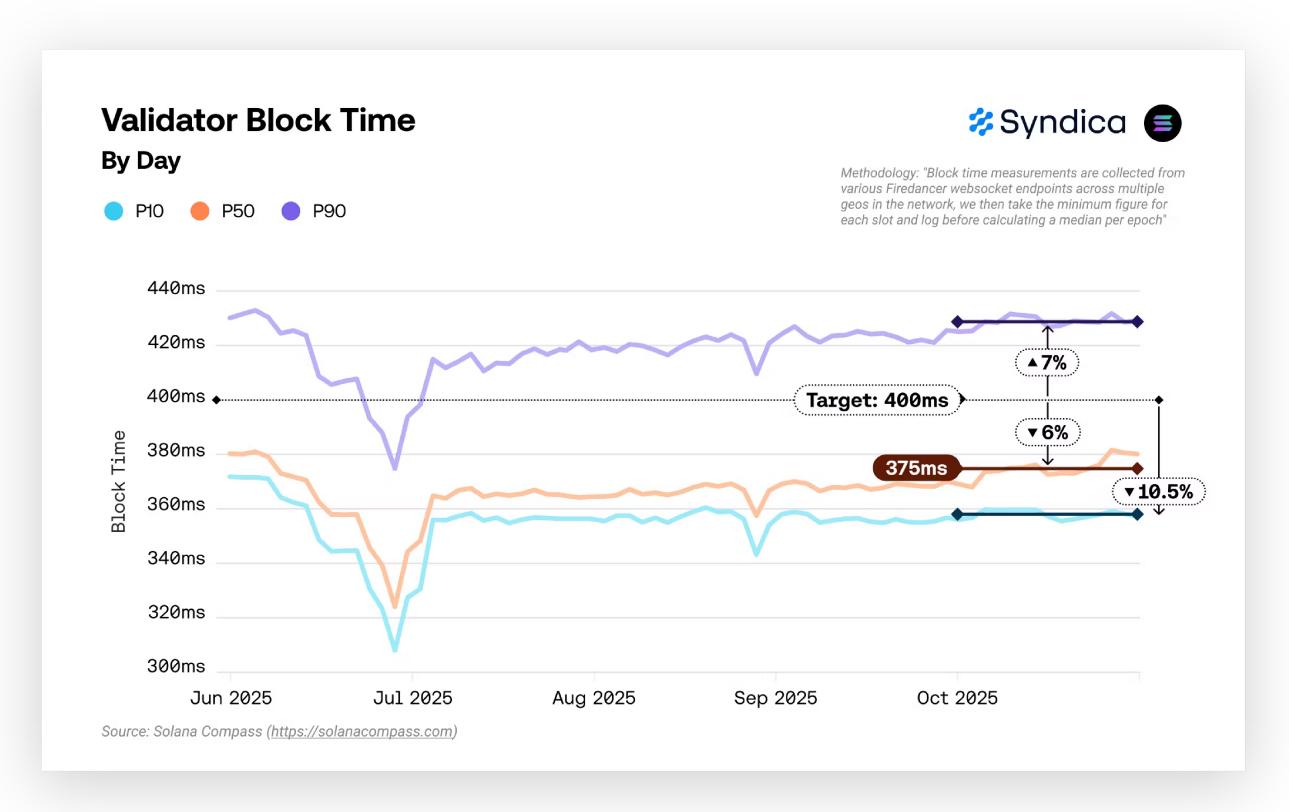
The median validator produces blocks at 375ms, 6% below target.

68% of validators produced blocks within 400ms in October.

The fastest 10% of validators produced blocks in 358ms, and the slowest 10% in 429ms.

Source: Solana Compass (https://solanacompass.com)
Methodology: "Block time measurements are collected from various Firedancer websocket endpoints across multiple geos in the network, we then take the minimum figure for each slot and log before calculating a median per epoch"

// Deep Dive: Network // October 2025



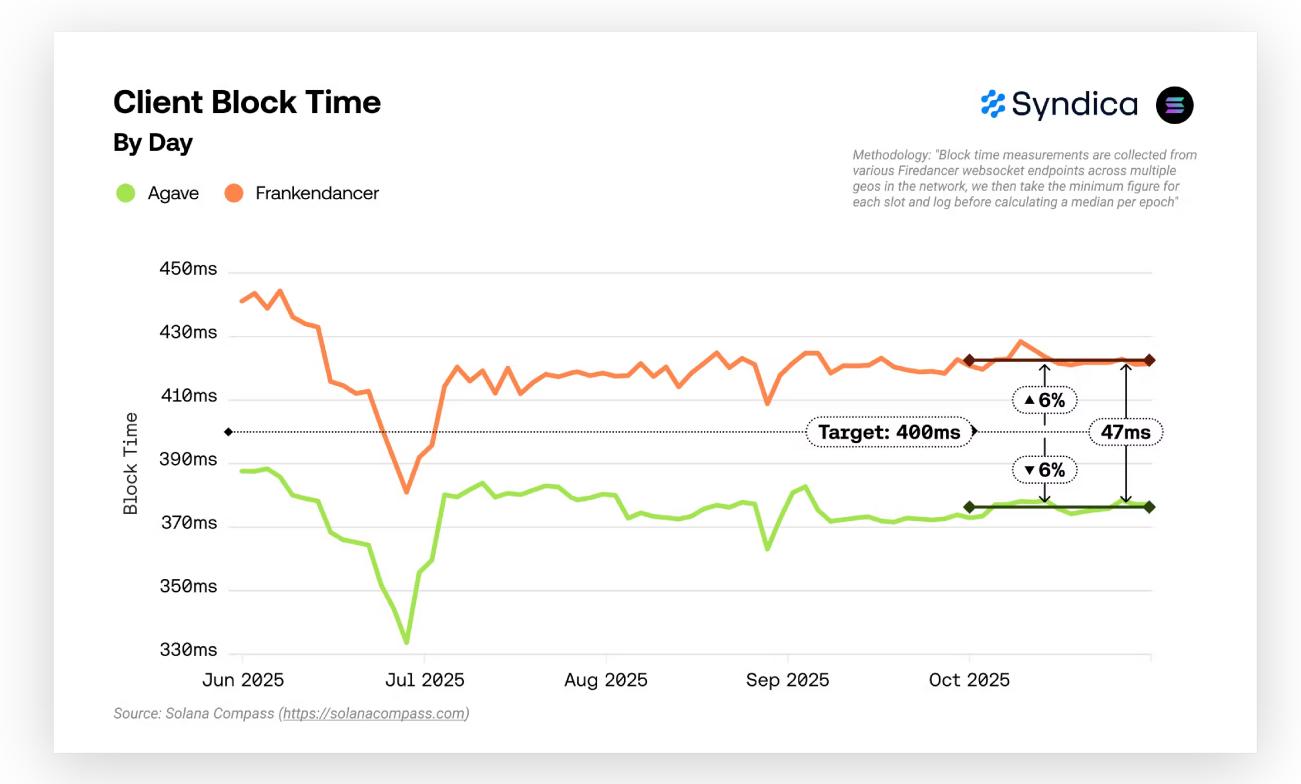


Agave validators produced blocks in 376ms, Frankendancer in 423ms.

Agave validators beat the 400ms target by 6% in October. Frankendancer validators ran 47ms slower than Agave and 6% above target.

This gap has persisted since June.

Source: Solana Compass (https://solanacompass.com)
Methodology: "Block time measurements are collected from various Firedancer websocket endpoints across multiple geos in the network, we then take the minimum figure for each slot and log before calculating a median per epoch"





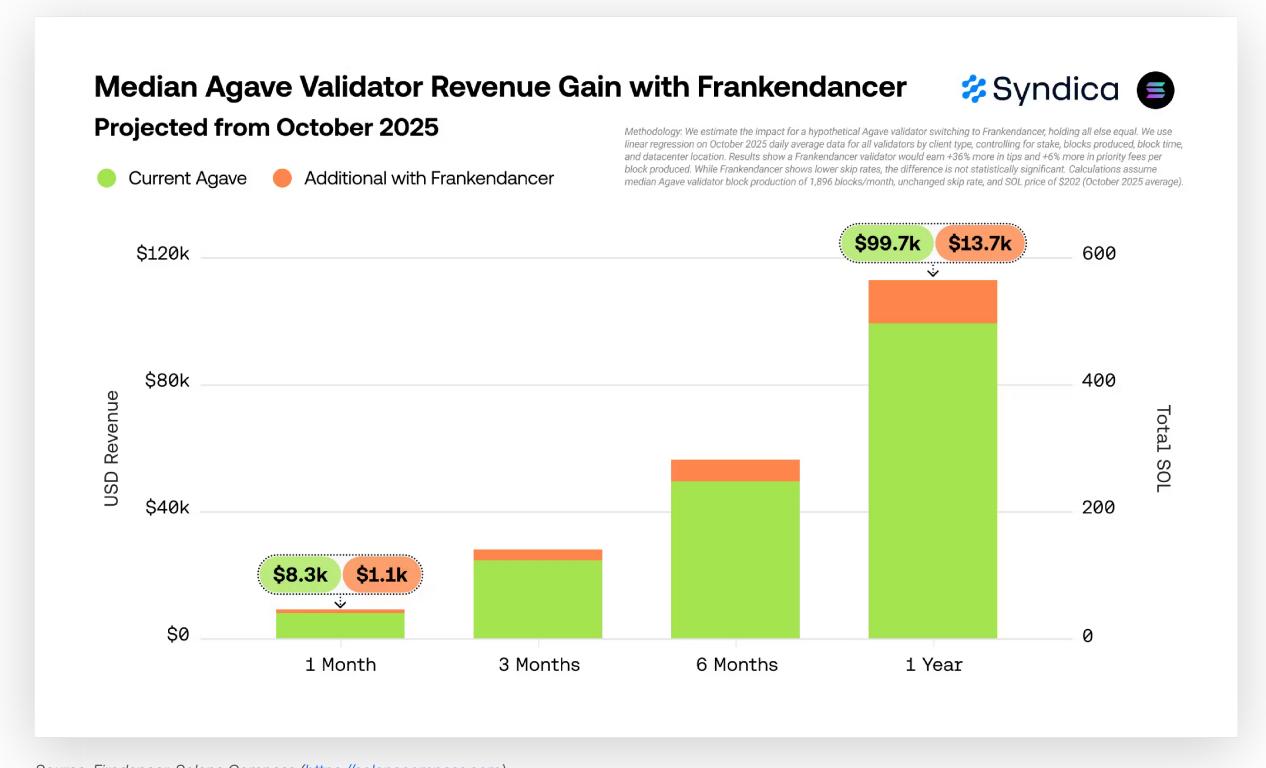
Frankendancer Premium



Switching to Frankendancer generates 14% more revenue.

The median Agave validator generated \$8,300 in monthly revenue from fees and tips in October.

Switching to Frankendancer would add \$1,140 (5.7 SOL) per month or \$13,650 (68 SOL) annually.



Source: Firedancer, Solana Compass (https://solanacompass.com)

Methodology: We estimate the impact for a hypothetical Agave validator switching to Frankendancer, holding all else equal. We use linear regression on October 2025 daily average data for all validators by client type, controlling for stake, blocks produced, block time, and datacenter location. Results show a Frankendancer validator would earn +36% more in tips and +6% more in priority fees per block produced. While Frankendancer shows lower skip rates, the difference is not statistically significant. Calculations assume median Agave validator block production of 1,896 blocks/month, unchanged skip rate, and SOL price of \$202 (October 2025 average).

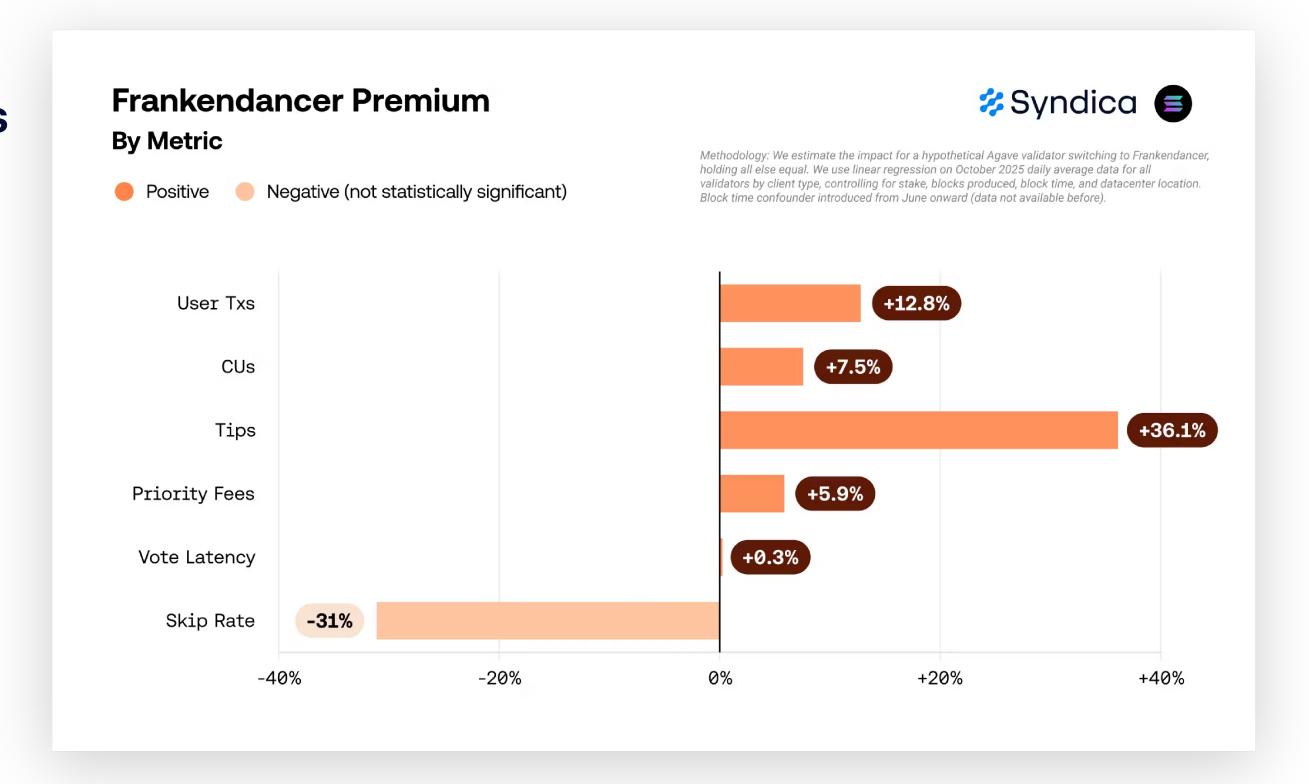


Frankendancer delivers higher throughput and revenue with no reliability cost.

By October 2025, Frankendancer validators process 13% more non-vote transactions, pack blocks with 8% more CUs, and earn 36% more in tips, and 6% more in priority fees per block than Agave.

These throughput and revenue gains come at very little cost to reliability: vote latency differs by just 0.3%, and skip rate differences are not statistically significant after controlling for confounders.

Source: Firedancer, Solana Compass (https://solanacompass.com)
Methodology: We estimate the impact for a hypothetical Agave validator switching to Frankendancer, holding all else equal. We use linear regression on October 2025 daily average data for all validators by client type, controlling for stake, blocks produced, block time, and datacenter location. Block time confounder introduced from June onward (data not available before).

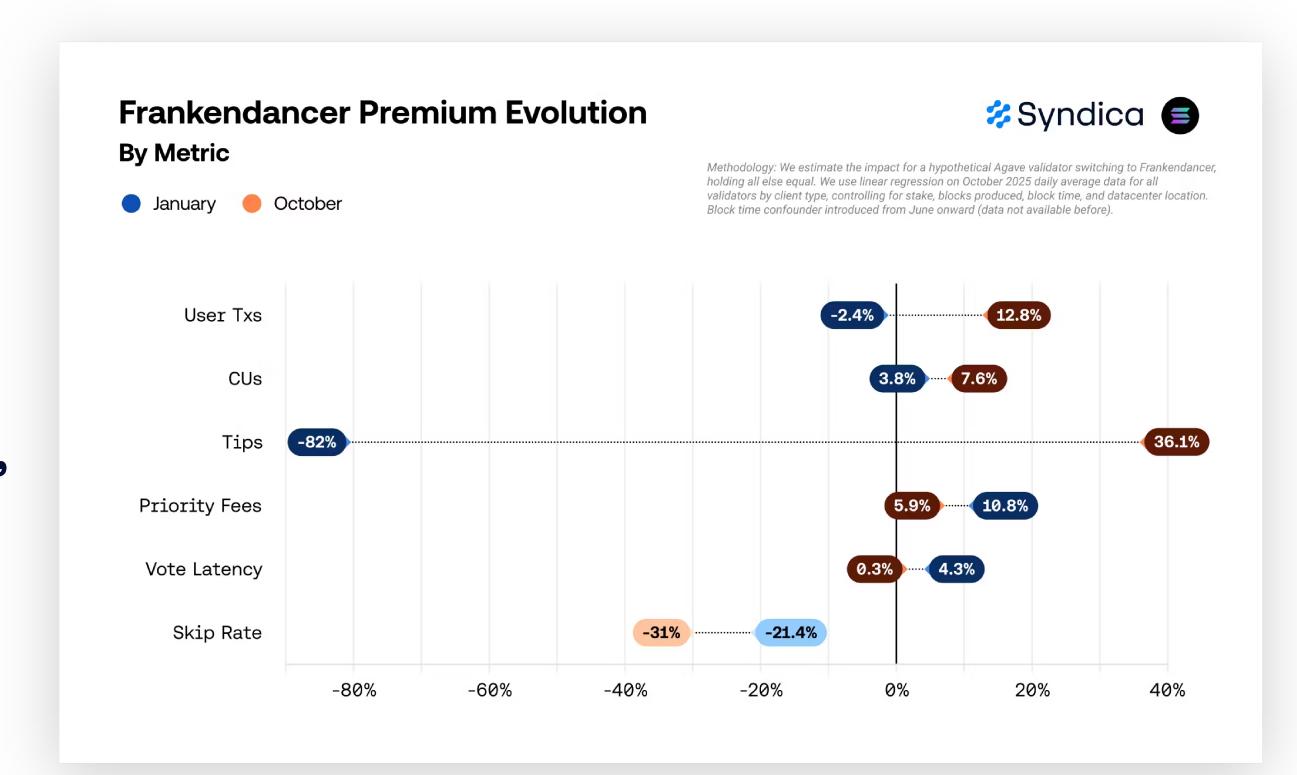




Frankendancer's performance advantage strengthened year-to-date across throughput, revenue, and reliability.

Source: Firedancer, Solana Compass (https://solanacompass.com)
Methodology: We estimate the impact for a hypothetical Agave validator switching to Frankendancer, holding all else equal. We use linear regression on October 2025 daily average data for all validators by client type, controlling for stake, blocks produced, block time, and datacenter location. Block time confounder introduced from June onward (data not available before).

// Deep Dive: Network // October 2025





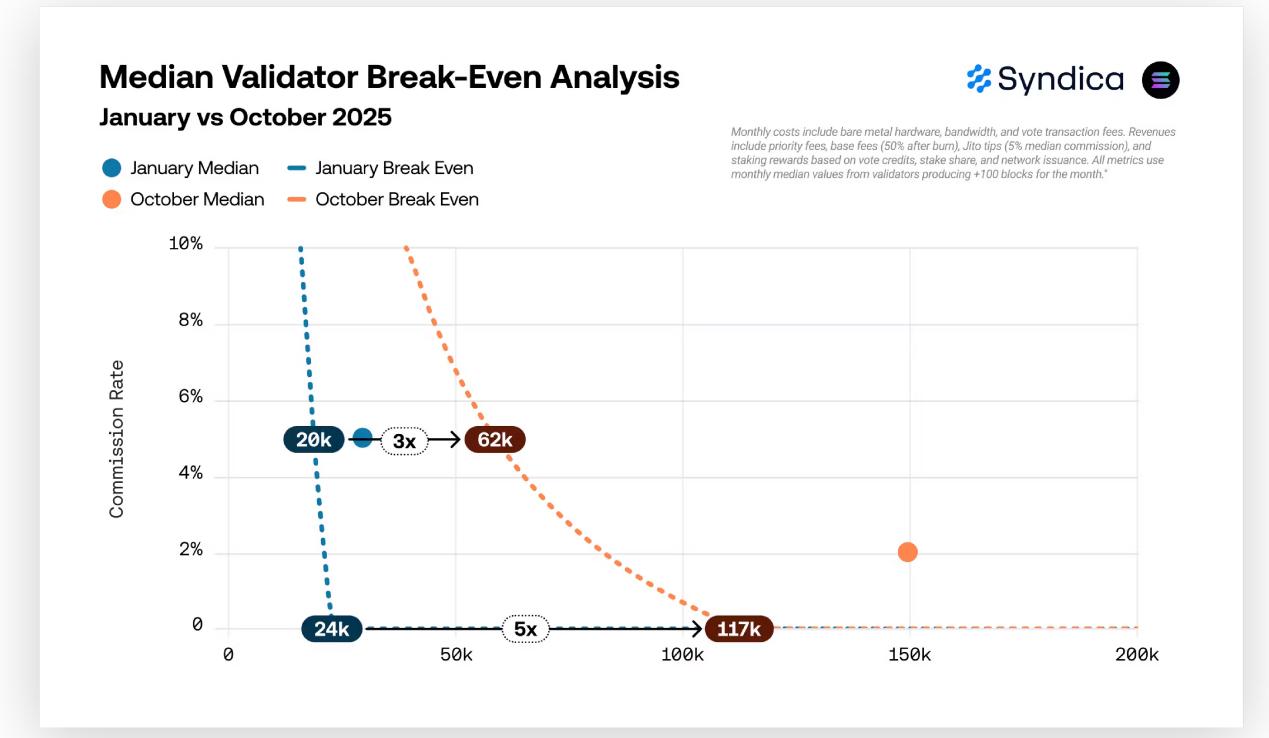
Part III Validators



Break-even stake requirements increased 5x from January to October.

As priority fees and tips declined, the minimum stake to operate profitably at 0% commission grew from 24k SOL in January to 117k SOL in October.

At 5% commission, the threshold increased 3x from 20k to 62k SOL.

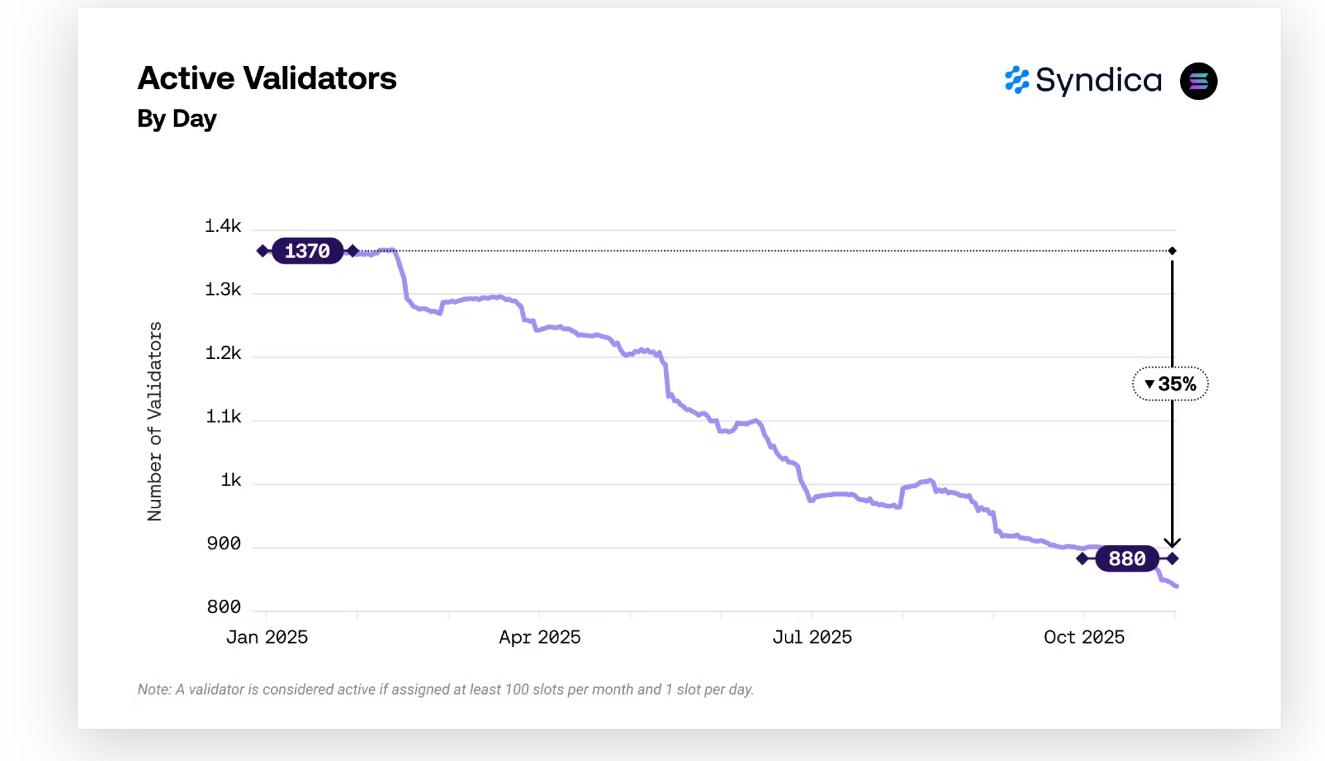


Monthly costs include bare metal hardware (\$496 for c3.large at latitude.sh), bandwidth (\$125 for 100 TB egress @ \$1.25/TB), and vote transaction fees (~216,000 votes/day @ 0.000005 SOL/vote = ~32.4 SOL/month). SOL prices use monthly averages. Revenues (calculated on earned blocks only, excluding skipped blocks) include 100% of priority fees, 50% of base transaction fees (50% burned), 5% of Jito tips (median commission from 792 validators in validators.app data), and staking rewards based on (vote_credits × validator_stake / network_total) × monthly_issuance × commission%. Timely Vote Credits (TVC) award 16 credits per vote for ≤2 slots latency, decreasing by 1 credit per additional slot (minimum 1 credit); median validators earn maximum credits with <1% variance. All validator metrics (stake, blocks, fees, tips, votes, latency) use monthly median values from validators meeting minimum block thresholds (100 blocks/month).



Validator count fell 35% since the start of the year.

Active validators declined steadily from an average of 1,370 in January to 880 in October.



Note: A validator is considered active if assigned at least 100 slots per month and 1 slot per day.

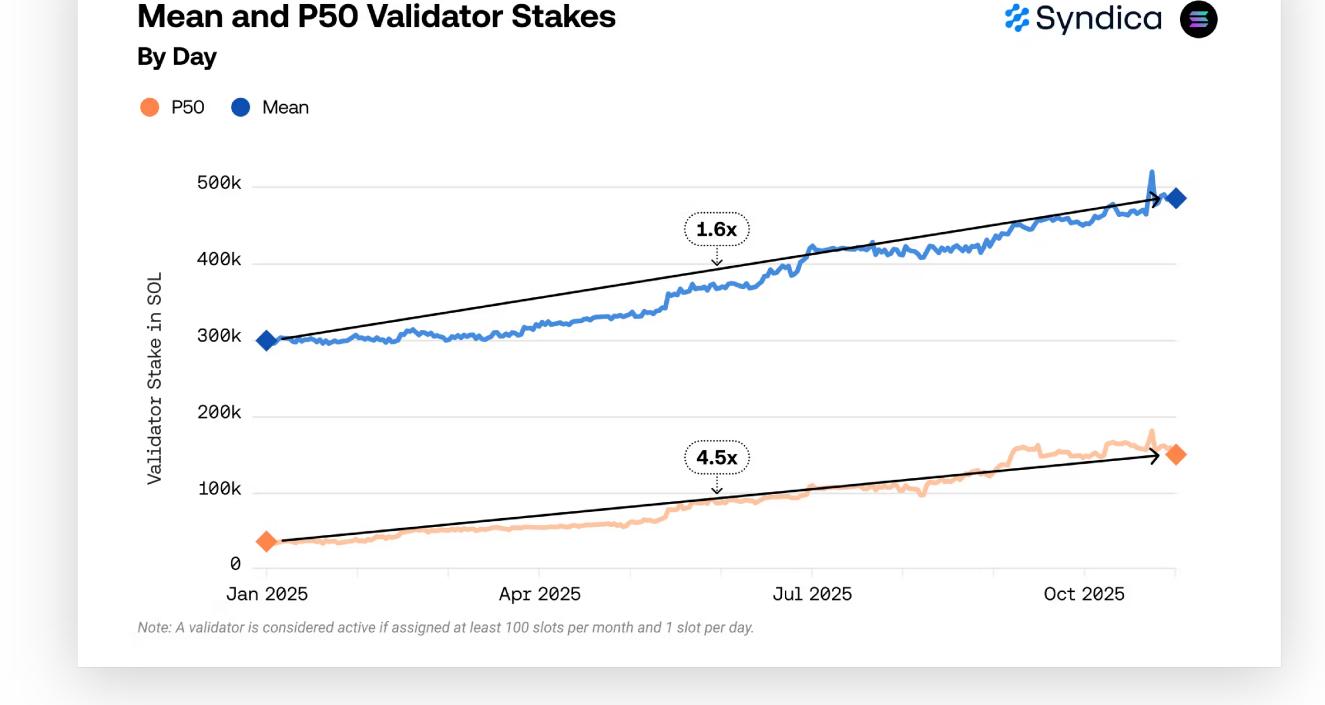
// Deep Dive: Validators // October 2025



Validator stake consolidated as median grew 4.5x, average 1.6x year-to-date.

The median validator held 158,000 SOL in October.

The average held 472,000 SOL.



Note: A validator is considered active if assigned at least 100 slots per month and 1 slot per day.

// Deep Dive: Validators // October 2025

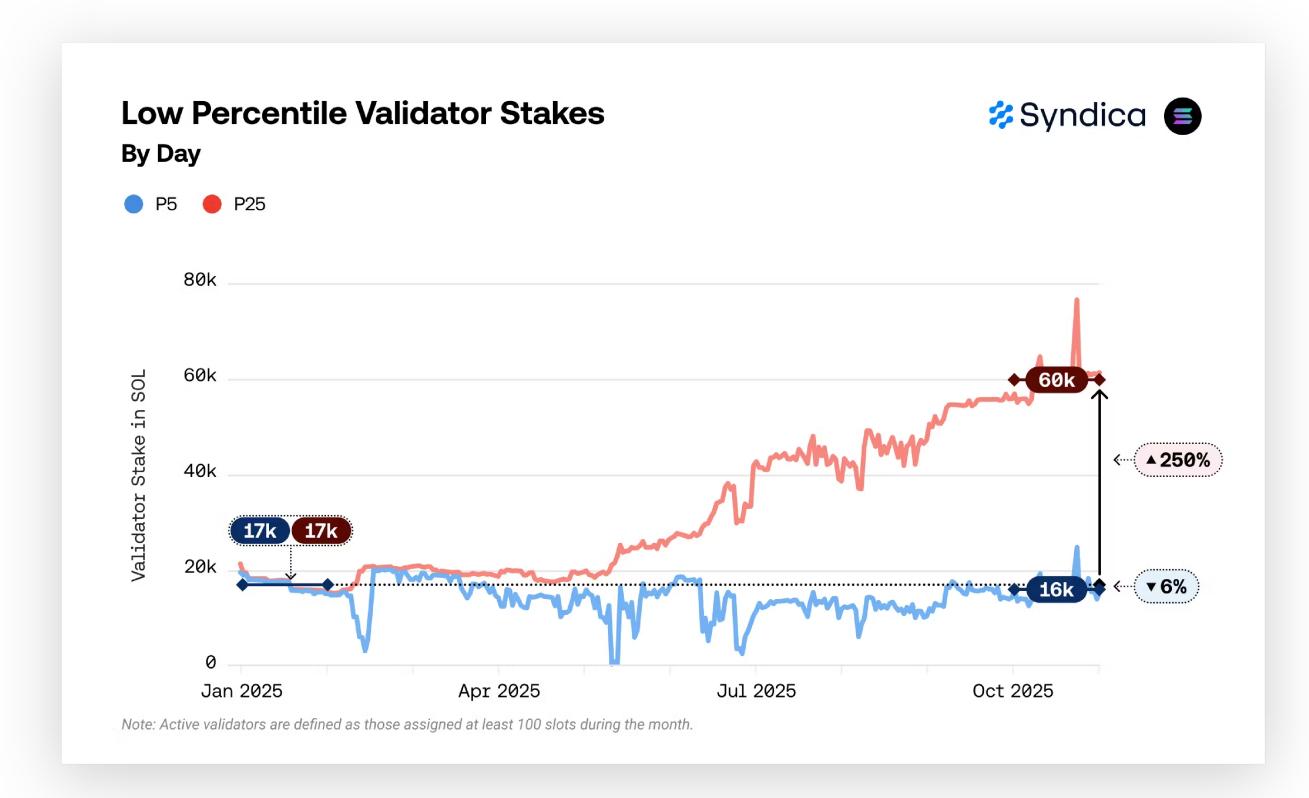


Stake inequality widened even among the smallest validators.

In January, p5 and p25 validators held nearly identical stakes around 17k SOL.

By October, p25 validators grew to 60k SOL (+250%) while p5 fell to at 16k SOL (-6%).





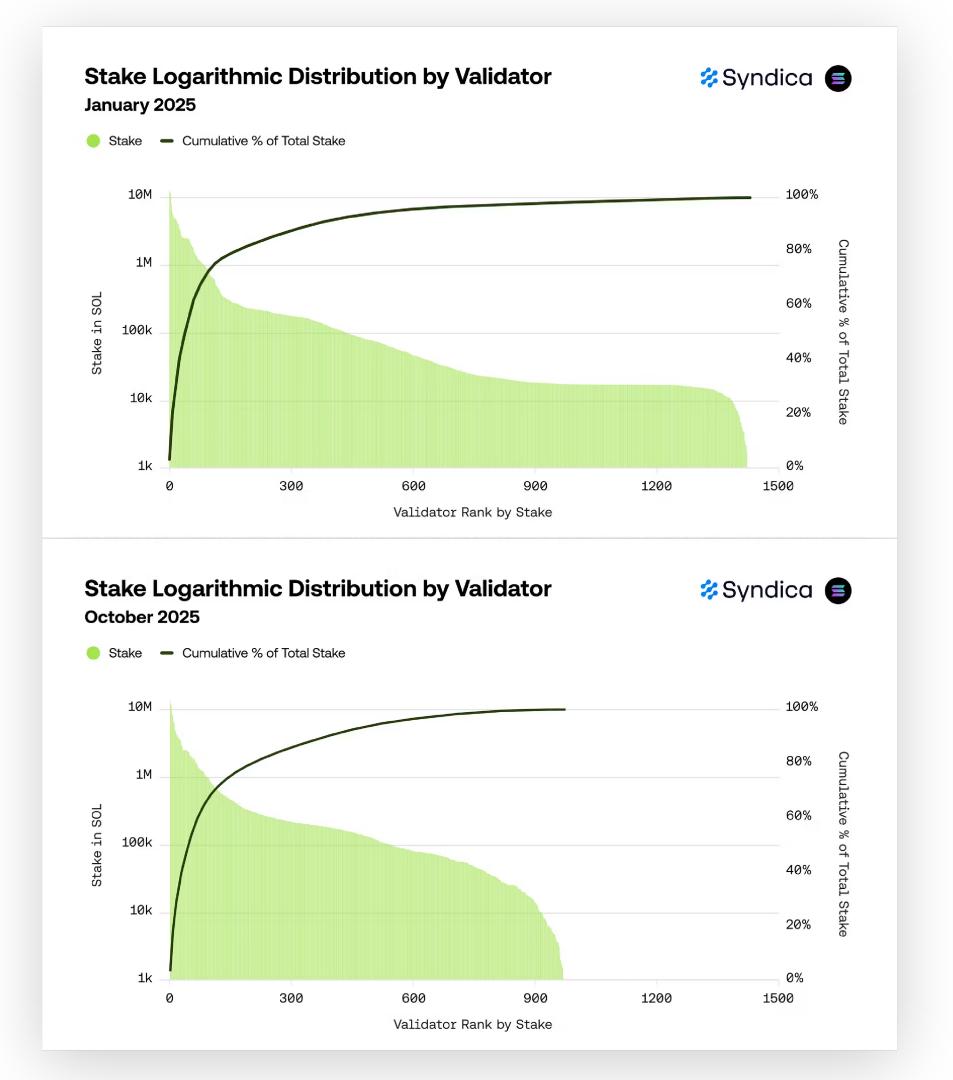


Validator stake distribution shifts from long tail to middle.

January's distribution had a long tail of small validators with a stake of 20,000 SOL or less.

By October, this tail disappeared. The remaining validators clustered more tightly around the middle, with significantly higher mean and median stake values.

Top validators control marginally lower stake than in January.





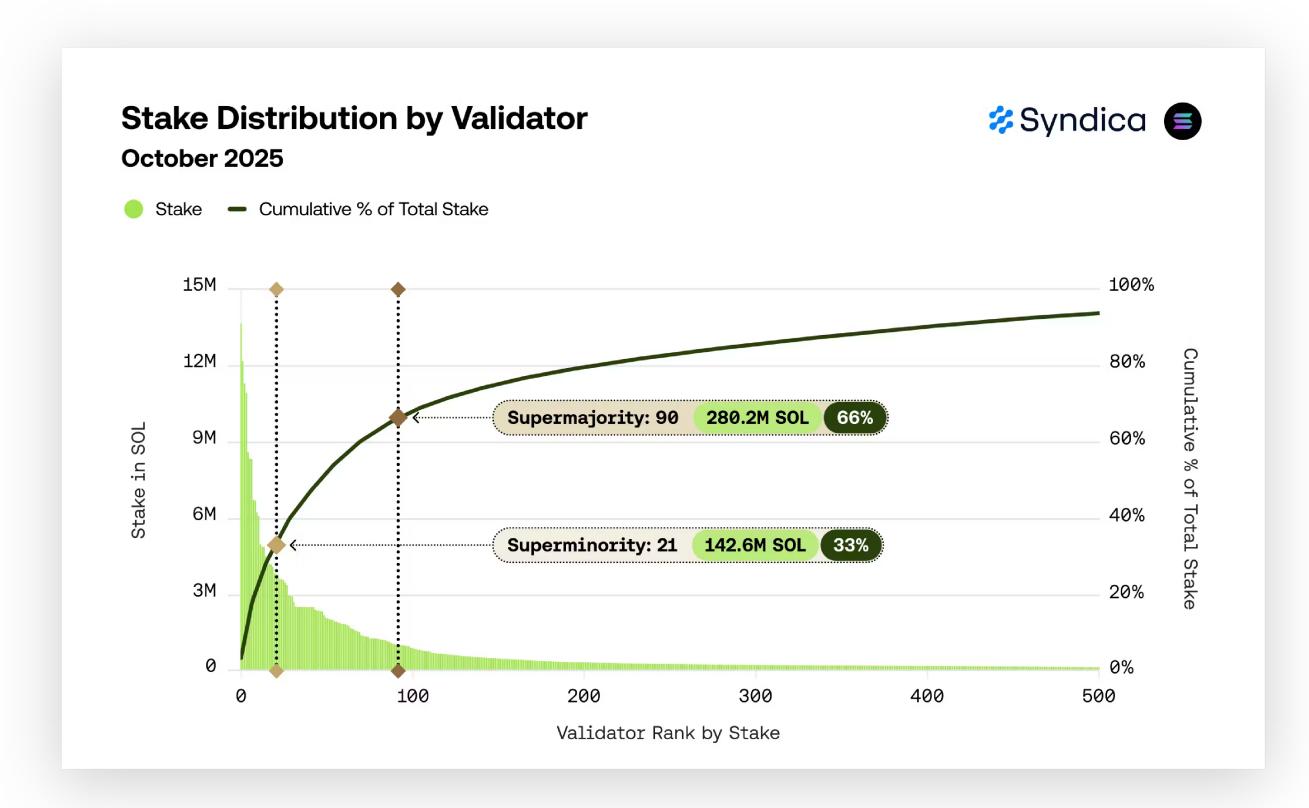
Part IV Decentralization



The top 10 validators control 23% of SOL staked.

Superminority (33% of stake needed to halt consensus) is reached at 21 validators.

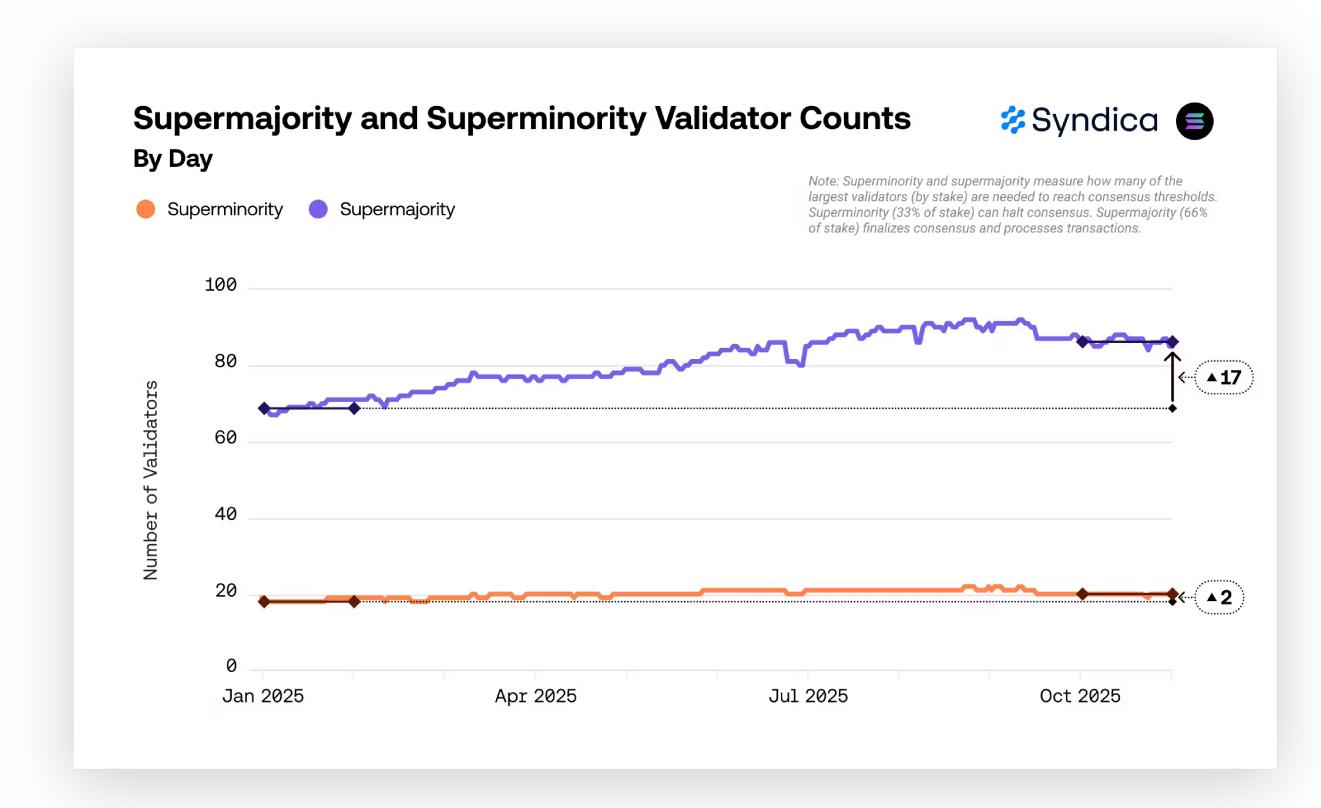
Supermajority (66% of stake needed to finalize consensus and process transactions) requires the top 90 validators.





Supermajority threshold rose by 17 validators, superminority rose by 2 since January.

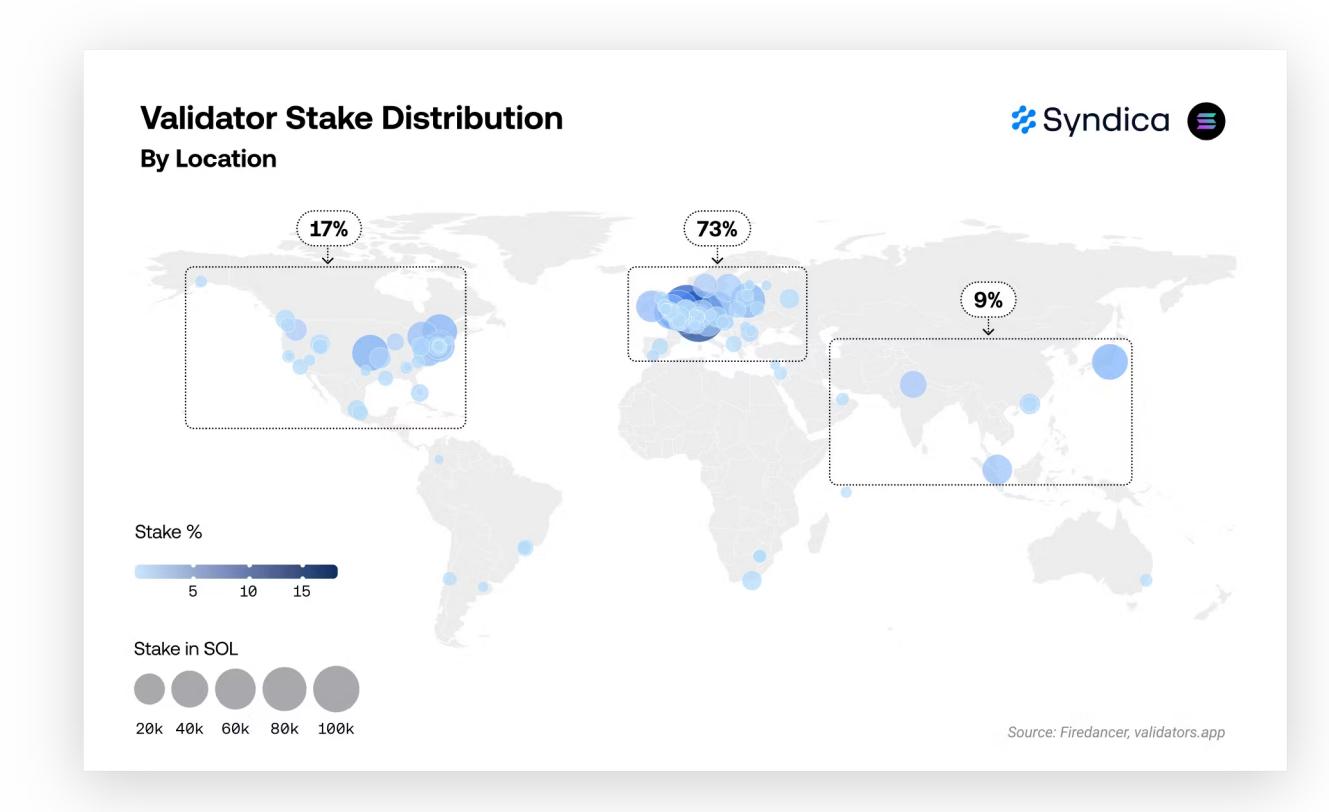
Note: Superminority and supermajority measure how many of the largest validators (by stake) are needed to reach consensus thresholds. Superminority (33% of stake) can halt consensus. Supermajority (66% of stake) finalizes consensus and processes transactions.





Nearly threequarters of validator stake sits in Europe.

European validators (including Russia) control 73% of network stake in October. North American validators hold 17%. Asian validators across Japan, Singapore, India, Hong Kong, and UAE combined hold 9%.

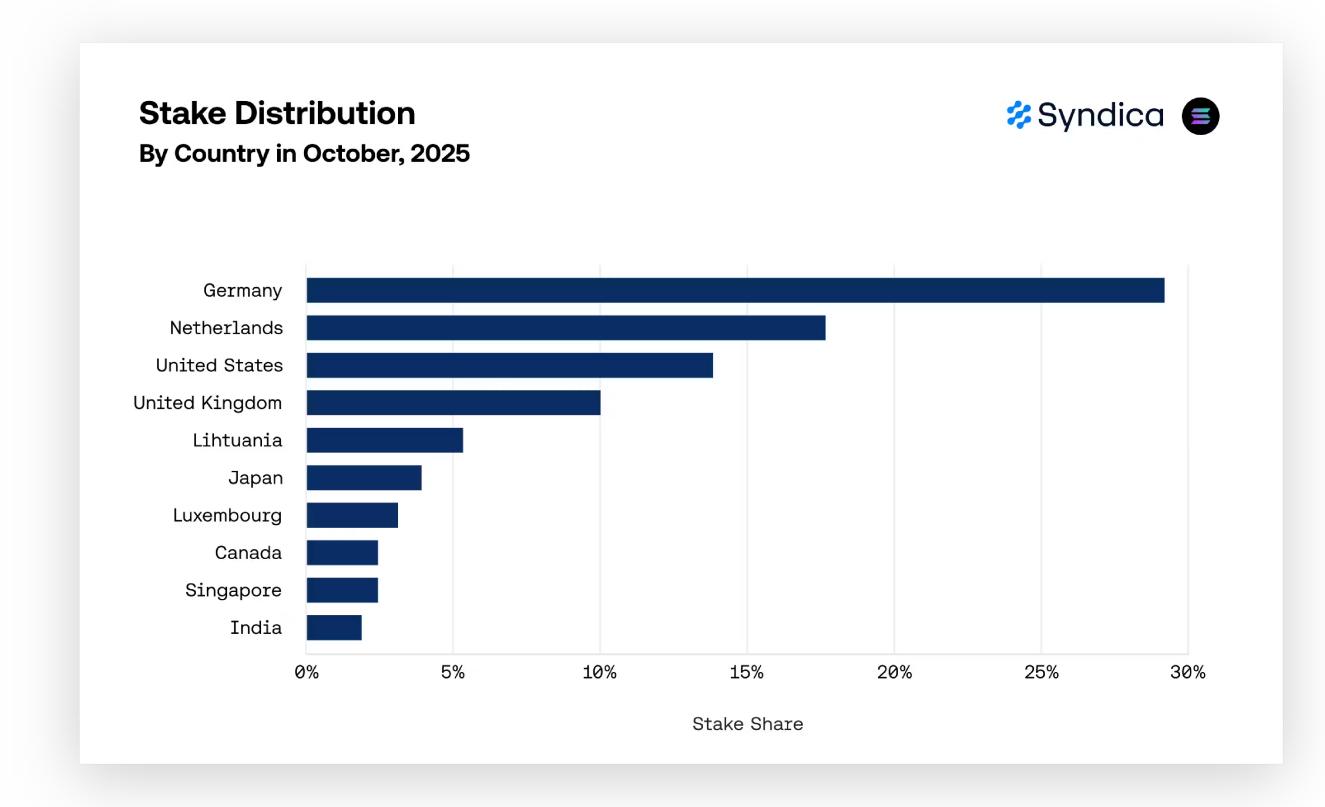




Three countries host validators that represent 61% of SOL staked.

Germany leads at 29%, followed by the Netherlands at 18% and the US at 14%.

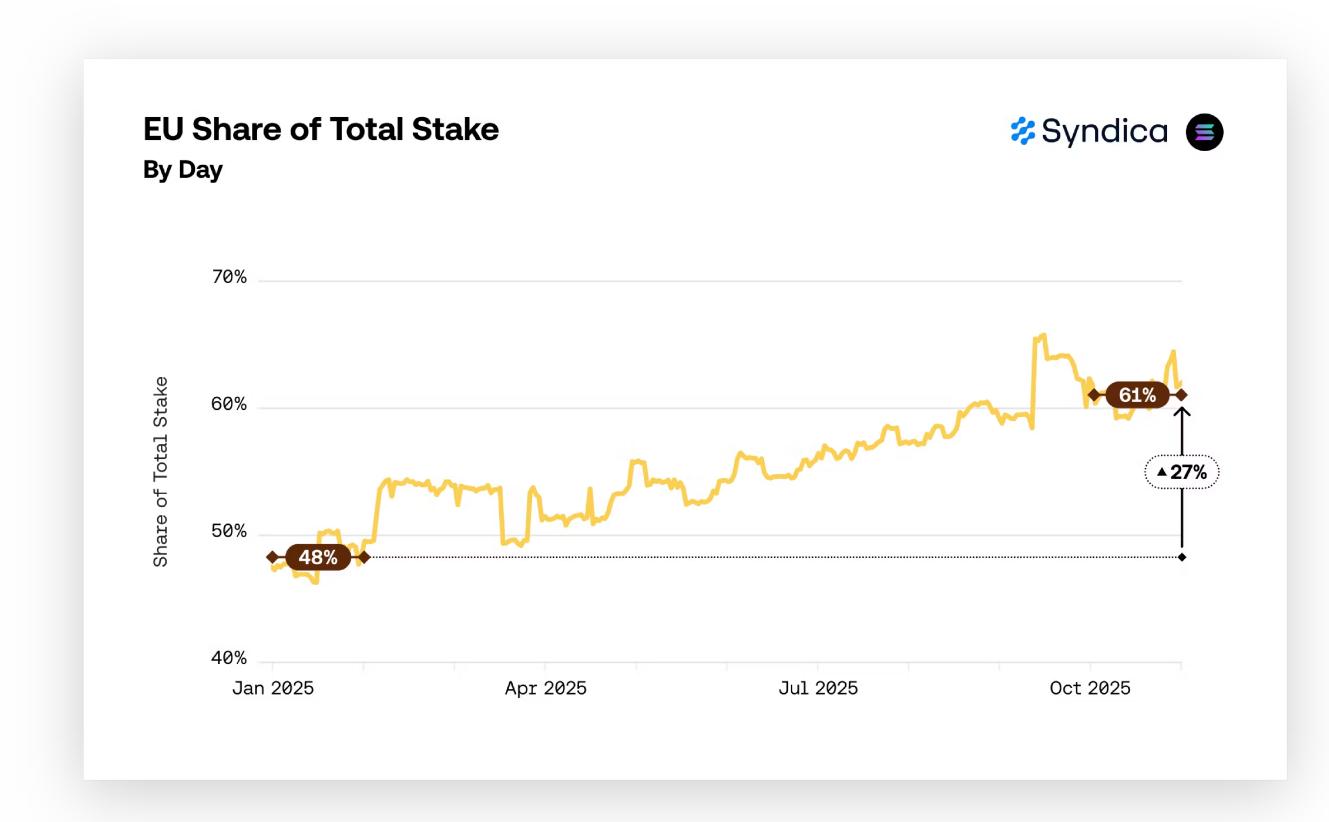
The top 10 countries account for 90% of total staked SOL.





EU holds 61% of validator stake, up from 48% in January.

This places the majority of SOL staked under one sole jurisdiction.





Part V Compute Units

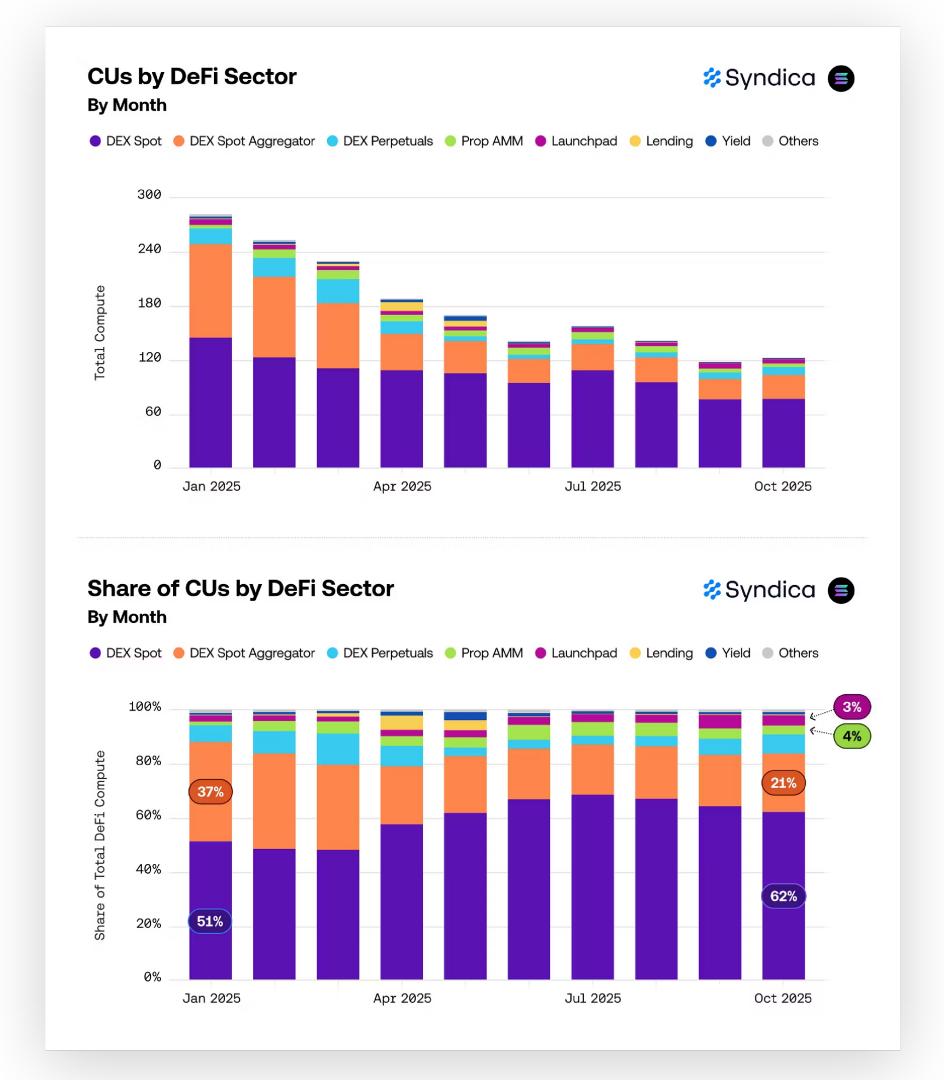


DeFi compute has fallen 60% since January as spot DEXs dominate.

Aggregate CUs spent on DeFi programs fell from 280 trillion to 120 trillion CU between January and October.

Spot DEXs captured a larger share, rising from 51% to 62%, while aggregators fell from 37% to 21%.

Prop AMMs and Launchpads increased their share of total DEX compute by 2.4x and 1.7x, respectively, but account for just 7% of DeFi compute combined.

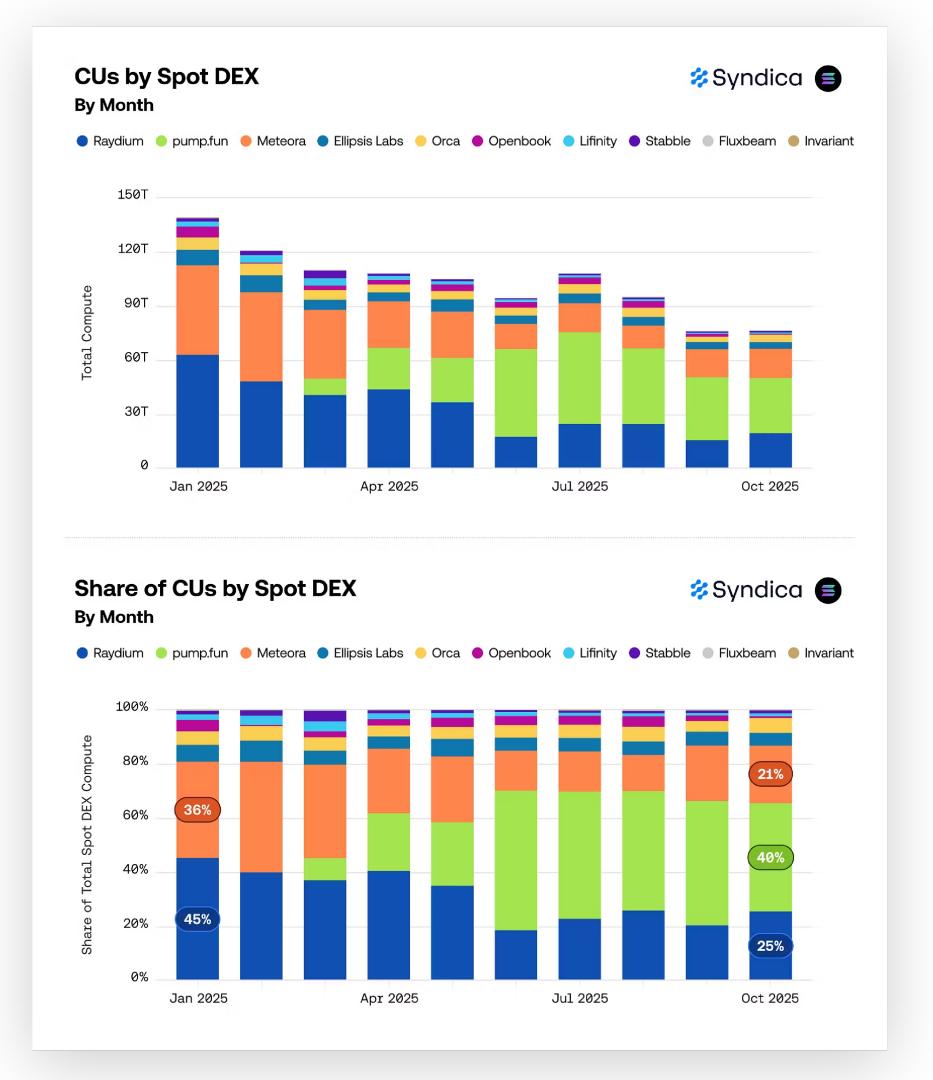




Pump.fun emerged as top spot DEX by compute.

Launched in March, pump.fun became the #1 spot DEX by compute by June. In October it accounted for 40% of CUs spent by spot DExs.

Raydium declined from 45% to 25% and Meteora from 36% to 21% since January.





Appendix Background Theory



Validators and Block Production

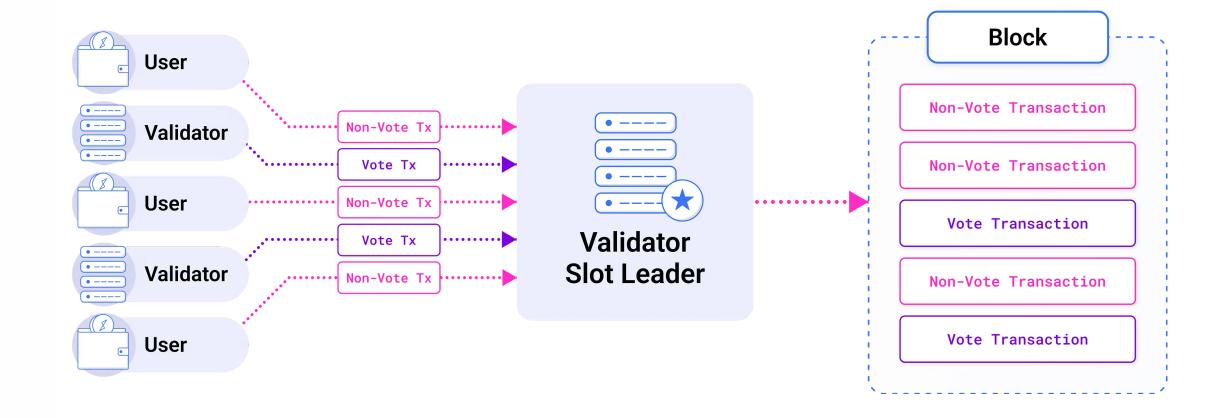
A **validator** is a computer or node that verifies the accuracy of transactions, creates new blocks, and participates in consensus.

A **slot** represents an allotment of time for which a block may be produced. Validators are assigned to act as **slot leaders** for a set of 4 consecutive slots.

During these 4 slots, the designated slot leader is responsible for creating blocks by bundling hundreds to thousands of transactions, which include both vote and non-vote transactions.

Validators submit **vote transactions** to reach consensus. One can understand it as validators casting votes to agree on what is happening within the Solana blockchain and what the correct order of events is.

Non-vote transactions are any other kind of transaction, like a swap, a token transfer, etc.

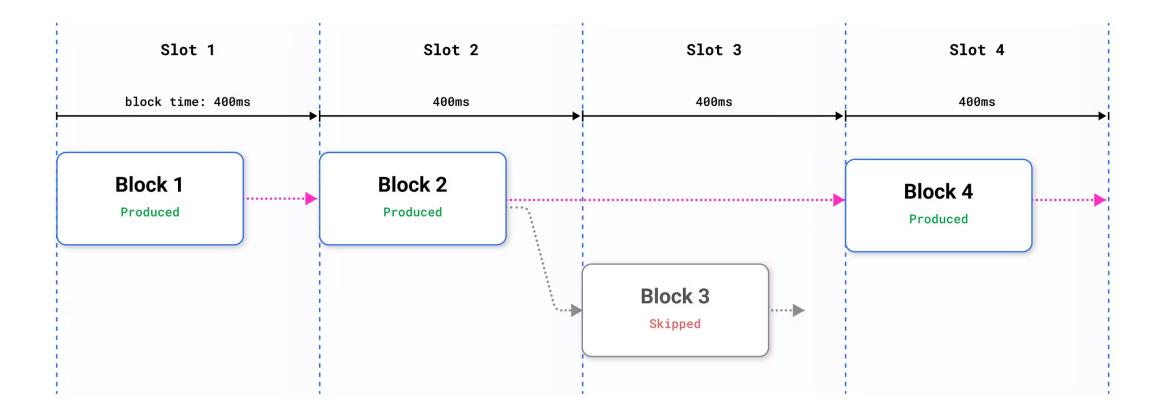




Measuring Network Performance

We will use four main metrics to measure Solana's network performance:

- 1. **Block time:** Measures how quickly blocks are created, with Solana aiming to produce one block every 400ms.
- 2. **Blocks produced:** Measures how many successful blocks Solana outputs, targeting 216,000 blocks per day.
- 3. **Skip rate:** When a slot leader fails to produce an acceptable block in their assigned slot, the block gets skipped. Skip rate tracks the ratio of skipped versus total slots.
- 4. **Vote latency:** Measures the time between when a block is produced and when a validator's vote for that block is included in a future slot. It is measured in slots, and the minimum possible latency is one slot.





What are compute units (CU)?

On-chain transactions consume computational resources, quantified in compute units (CU). Each CU generally corresponds to one Berkeley Packet Filter (BPF) instruction (e.g., basic arithmetic like addition or subtraction), with estimates for more complex ones.

BPF started as a kernel tool for efficient packet filtering in Linux, later extending to eBPF for broader, highperformance applications in networking and tracing. Solana uses sBPF, a modified version that creates a virtual machine for eBPF programs.

Block Compute Budget

- Each block: limit of 48M CU (raised to 50M CU on April 10 and again to 60M CU on July 22)
- Blocks consist of multiple transactions
- Each transaction deducts CU from the block budget

1 = CU Limits

- Maximum: 1.4M CU per transaction
- Transactions are split into instructions
- Users specify a compute limit for the entire transaction, up to 1.4M CU.
 Without a specified limit, the default is 200k CU per instruction



Understanding Solana's fee structure

There are three types of transaction fees in Solana: base, vote, and priority.

- Transaction fees are fixed at 5,000 lamports per signature. 50% goes to the block leader, 50% is burnt. They apply to:
 - Non-vote transactions for user activity, like swaps and transfers, are commonly known as base fees
 - Vote transactions (validators participating in consensus), known as vote fees
- Priority fees are optional user payments to prioritize transaction inclusion. They are calculated by multiplying the transaction's compute unit limit by a user-defined price per compute unit.
- Tips are extra SOL payments users make to validators to speed up transaction inclusion.



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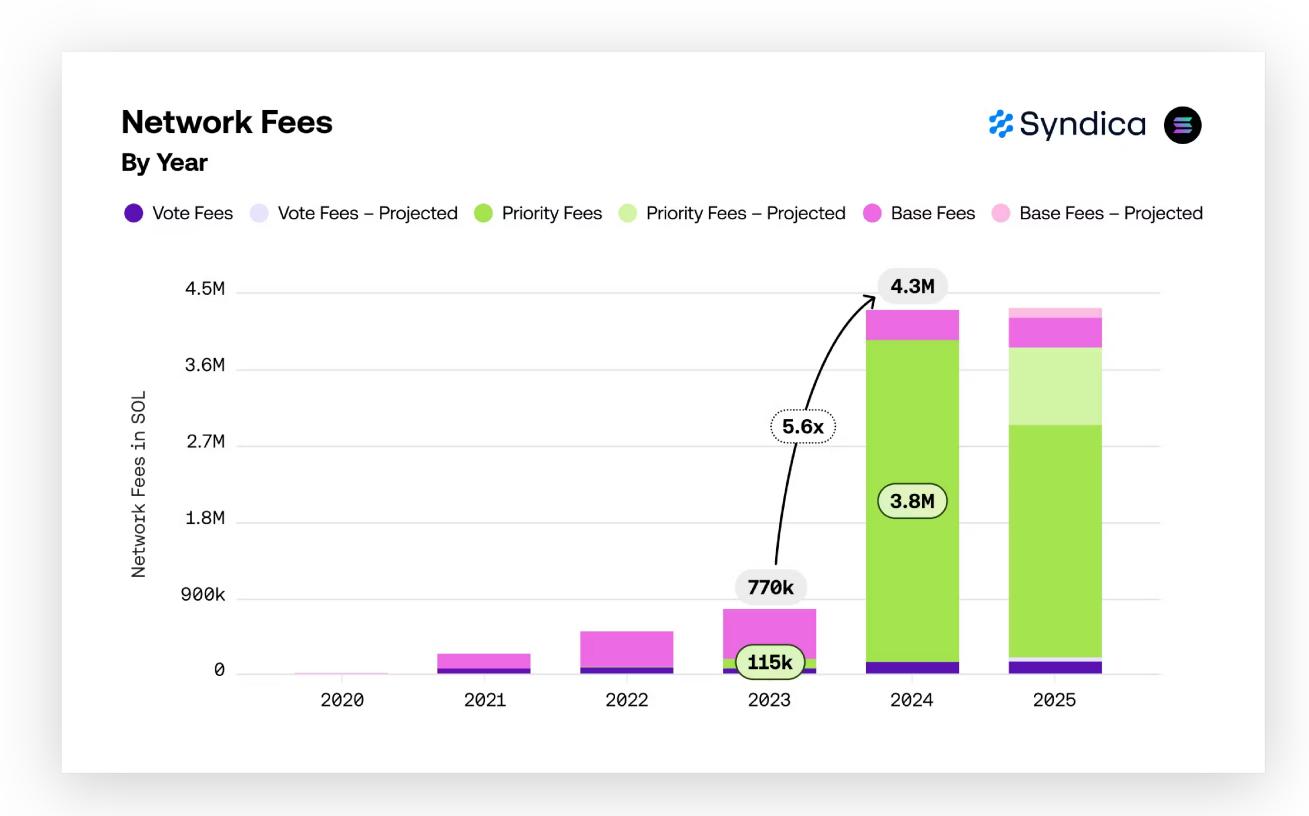
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Priority fees dominate as total fees stabilize.

Priority fees drove Solana's fee growth in 2024, surging from 115K SOL to 3.8M SOL and pushing total fees up 5.6x to 4.3M SOL.

Fees in 2025 are projected to stay flat year-over-year.

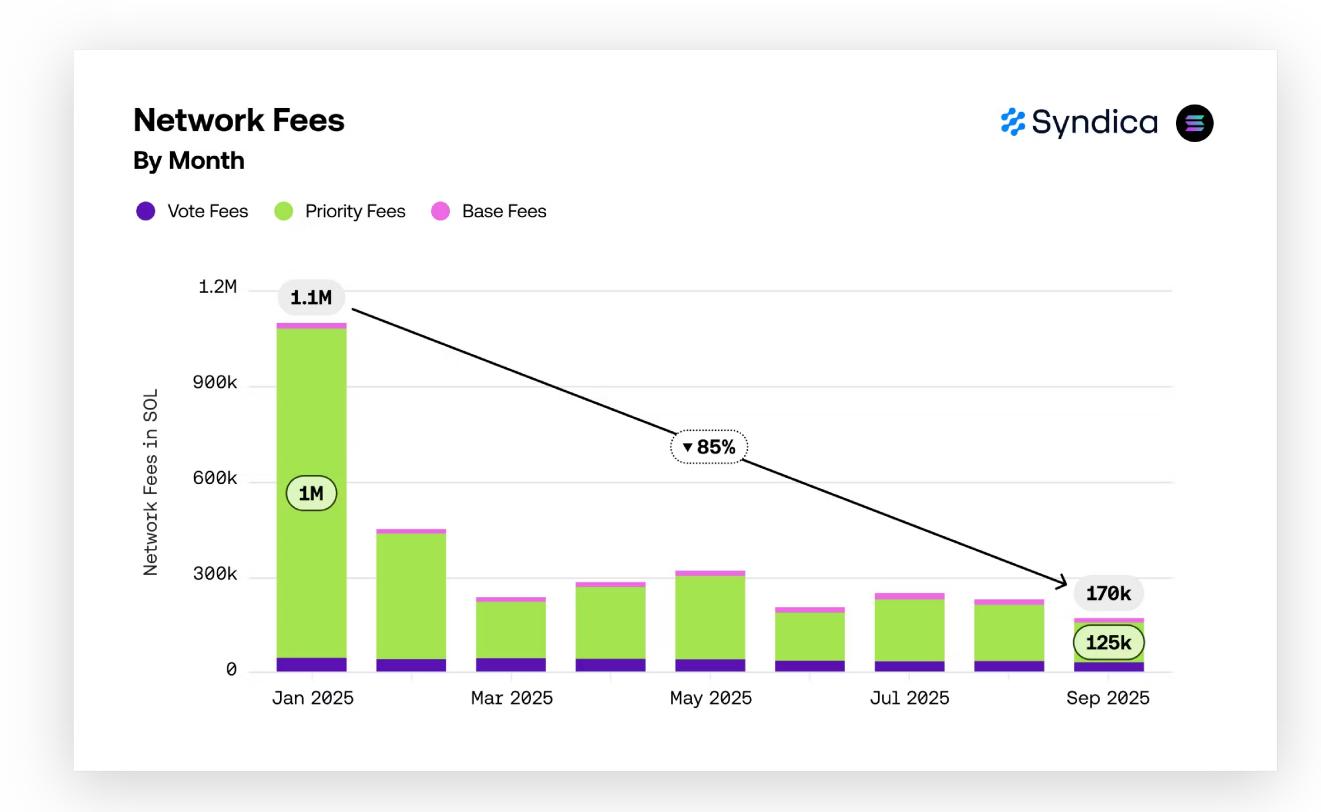




September fees hit yearly low at 170K SOL.

Monthly fees in 2025 reached their lowest point in September at 170,000 SOL, down 85% from January's peak of 1.1 million.

Priority fees have driven this decline, collapsing from 1.0 million SOL to 125,000 over the same period. The trend mirrors the decrease in TPS and compute usage.



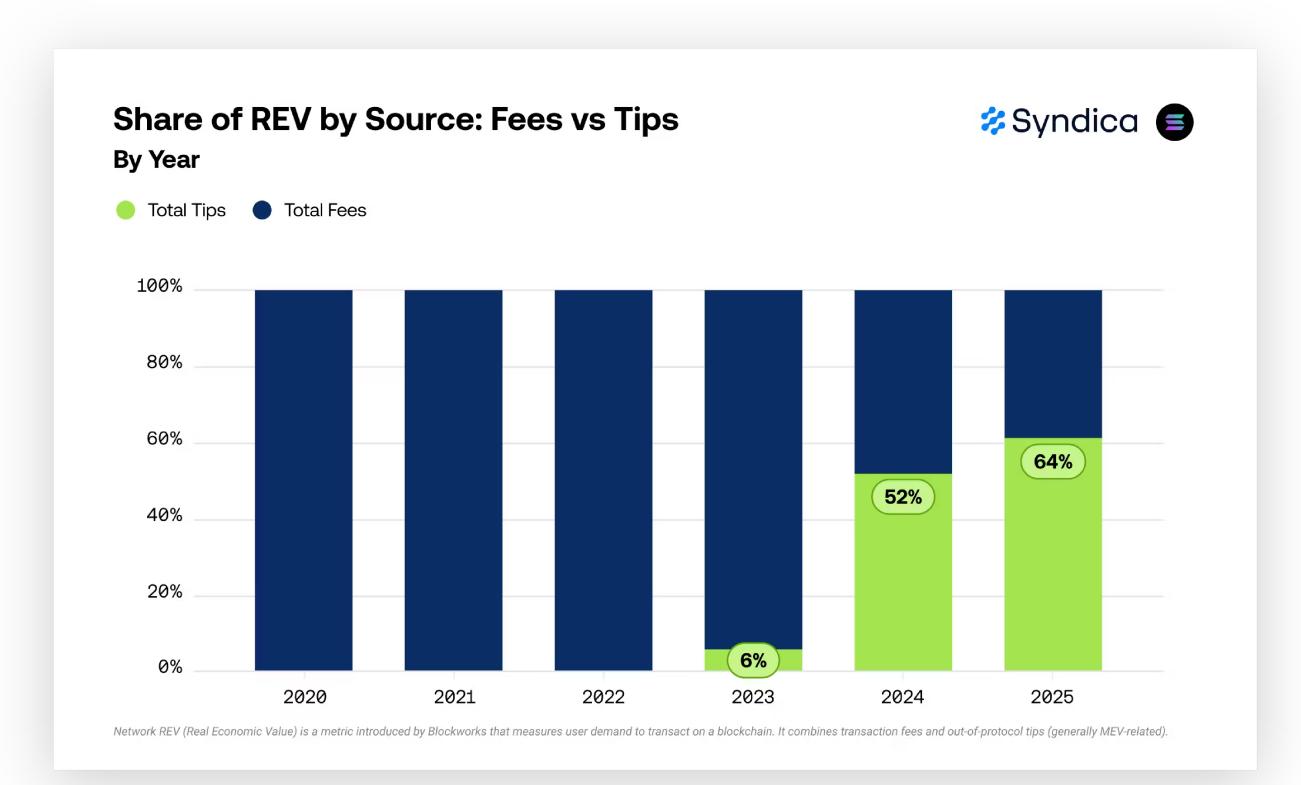


Tips now exceed fees as primary validator revenue source.

Tips have grown from 6% in 2023 to 52% in 2024 and are projected to reach 61% of the network's REV in 2025.

Note: Network REV (Real Economic Value) is a metric introduced by Blockworks that measures user demand to transact on a blockchain. It combines transaction fees and out-of-protocol tips (generally MEV-related).

// Deep Dive: Network // October 2025



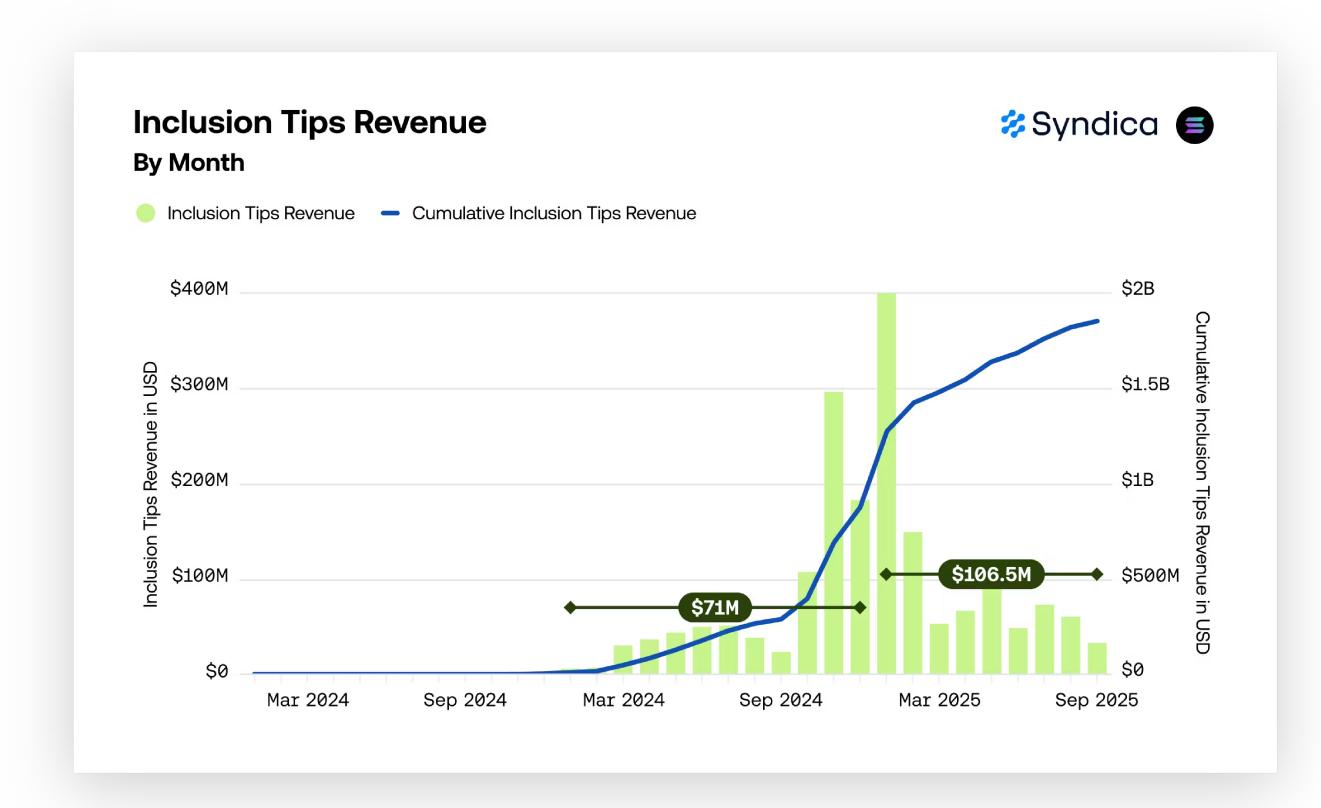


2025 tip revenues up 50% year-over-year.

Monthly tips average \$106.5M in 2025, up from \$71M in 2024. 2025 revenues to date have already surpassed 2024's full-year revenues.

January peaked at \$392M during the TRUMP memecoin launch, cooling to September's low of \$32M.

Cumulative tips since January 2023 have reached \$1.8B.

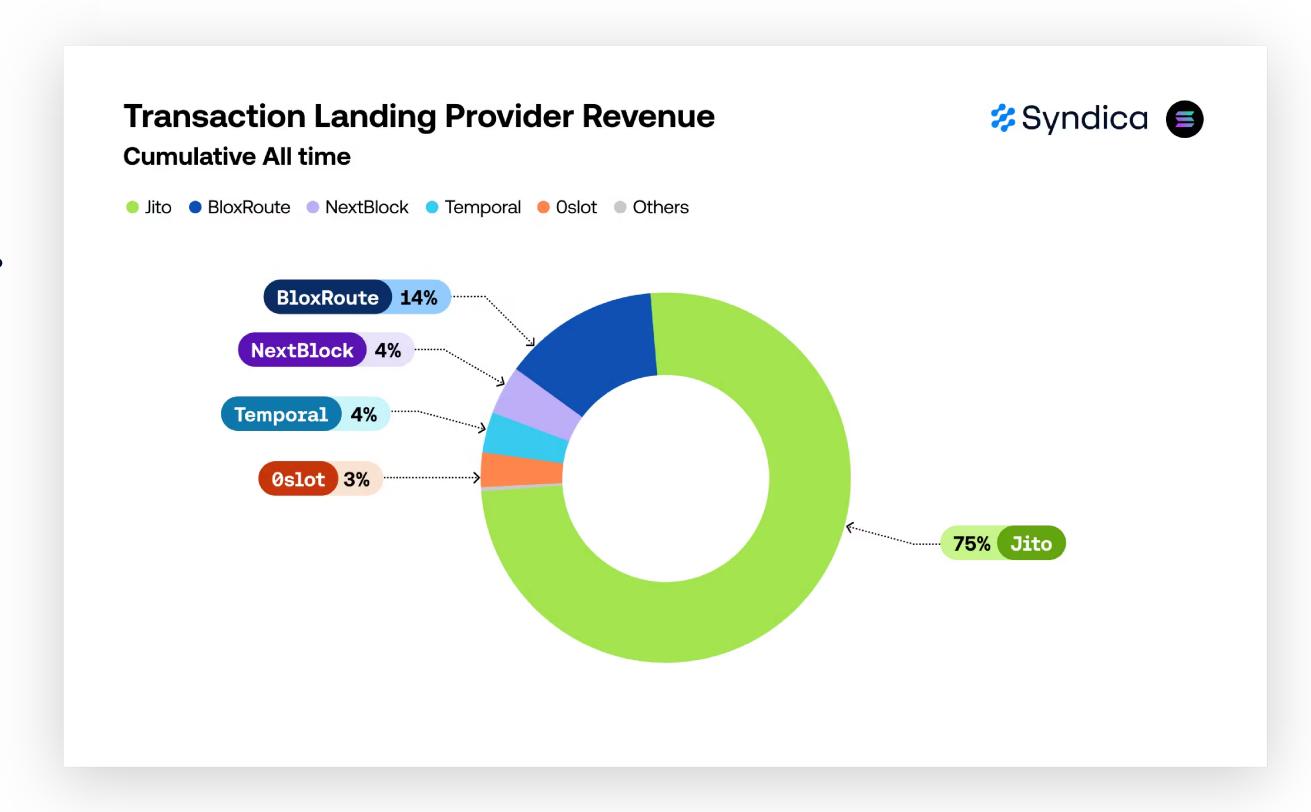




Jito dominates with 75% of all-time tip payments.

Jito dominates transaction inclusion tipping with \$1.36B (75%) of the total cumulative revenues. Adding BloxRoute's \$250M, just two providers capture 89% of all revenue.

Nextblock, Temporal, and 0slot have collectively earned \$196M (11%), while six smaller providers split \$6.8M (0.4%).



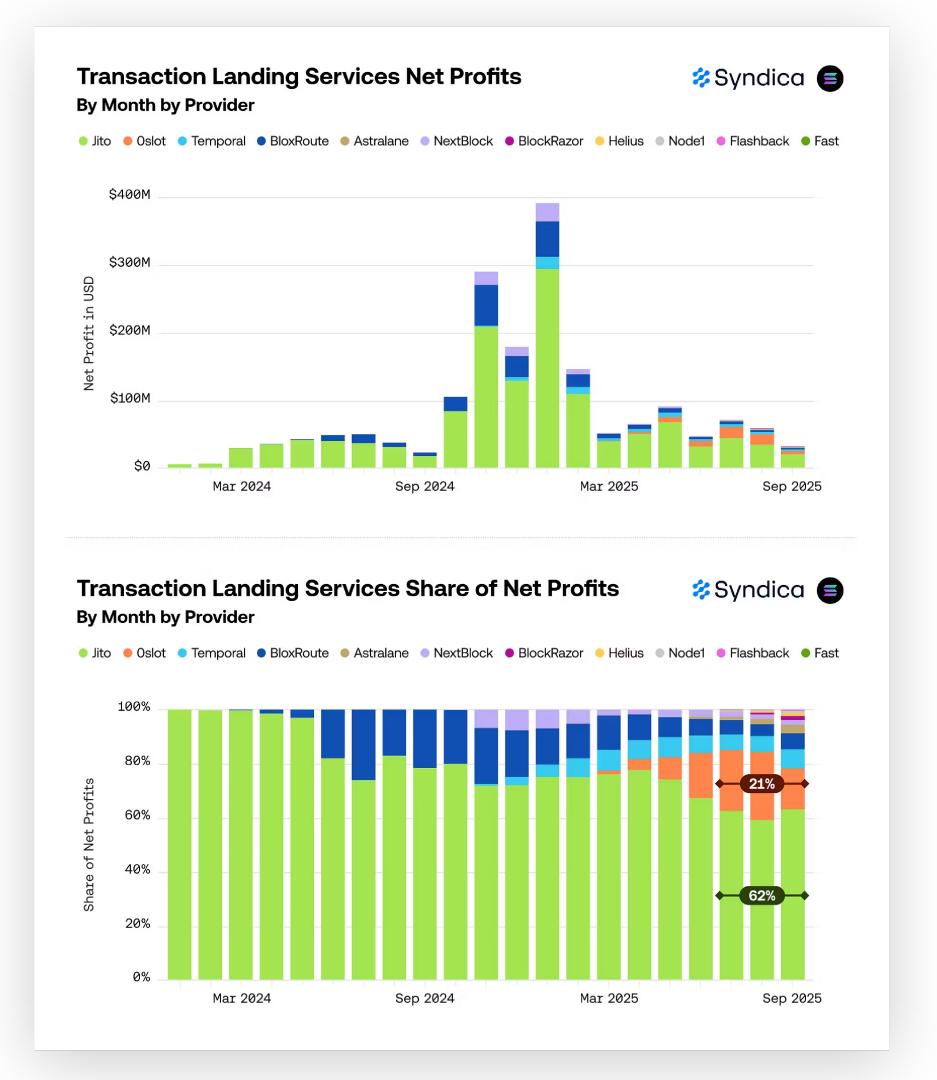


Transaction inclusion tip market fragments as total pie shrinks.

Jito dominated the early market and maintains 61.5% by Q3 2025.

BloxRoute reached 20% share in H2 2024, followed by Nextblock and Temporal in late 2024 (7.5% each at peak). Oslot surged to 21% in Q3 2025 alongside numerous smaller providers.

However, new entrants captured share in a shrinking market, earning less revenue.





DoubleZero launches mainnet with 22% of Solana stake.



Monitor the network at:

doublezero.xyz/dashboard

DoubleZero launched on mainnet October 2nd, aiming to address the limitations of the public internet when interconnecting distributed systems.

Blockchain performance is increasingly limited by network infrastructure rather than computational capacity. DoubleZero addresses this by creating a decentralized network of contributed fiber links that offer two key advantages:

- Specialized hardware filters inbound transactions, removing spam and duplicates before they reach validators
- Outbound messages are explicitly routed and prioritized, reducing jitter and improving consensus speed.

This delivers the performance benefits that companies like Amazon and Google achieve through private networks, but without introducing trusted intermediaries.



Part II Validator Clients



Solana Clients

Note: In the following section, we analyze the performance of these clients and their flavours across metrics like vote latency and skip rate since January 2025. All metrics are weighted by the number of blocks produced by each client during the analysis period.

These metrics are influenced by factors beyond client choice, including geographical location, or how the validators priortitize transactions and build blocks. Though ideal comparisons would control for validator specifications, stake and locations, this historical analysis still offers useful insights.

Most of the data used in this analysis comes from the dashboard reports.firedancer.io, maintained by the Firedancer team.

// Deep Dive: Validator Clients // October 2025

Base Clients

- Agave (live): main Solana validator Client maintained by Anza, continuing the work of the Solana Labs client. Serves as the reference implementation for the network.
- Frankendancer (live): hybrid client as a transitional step towards the full Firedancer client being developed by Jump Crypto. It combines the original consensus and runtime components from Agave with Firedancer's new, optimized networking components, signature verification, and block packing.
- **Firedancer (in production)**: high-performance validator client developed by Jump Crypto in C.
- **Sig (in production)**: a complete rewrite of the Solana client developed by Syndica in Zig. Sig optimizes read operations and RPC performance.

Flavours of Base Client

- Vanilla: default Agave/Frankendancer clients.
- **Jito:** modified version of the core client with built-in Maximum Extractable Value (MEV) auction and block engine to maximize revenue and potentially increase reliability and performance.
- Paladin: modified Jito client that aims to protect validators from sandwhiching and distribute MEV rewards across Paladin validators.



Clients live on mainnet

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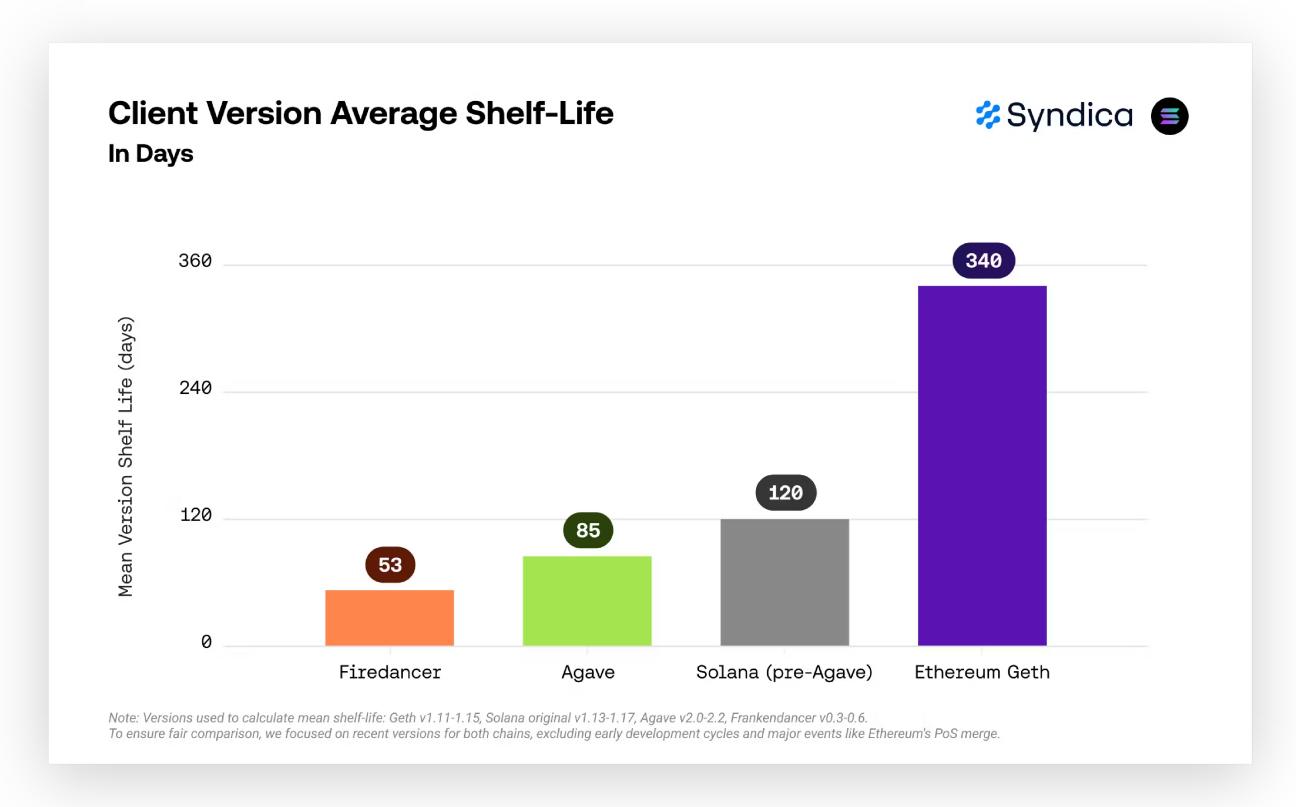
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Agave and Frankendancer ship new versions every 2-3 months.

Shelf-life tracks how long each version maintains supermajority before being replaced. Recent Agave versions turn over every 85 days on average, Frankendancer every 53 days.

By contrast, Ethereum's Geth averages 340 days, and the original Solana client had a turnover of 120 days before Agave.



Note: Versions used to calculate mean shelf-life: Geth v1.11-1.15, Solana original v1.13-1.17, Agave v2.0-2.2, Frankendancer v0.3-0.6. To ensure fair comparison, we focused on recent versions for both chains, excluding early development cycles and major events like Ethereum's PoS merge.

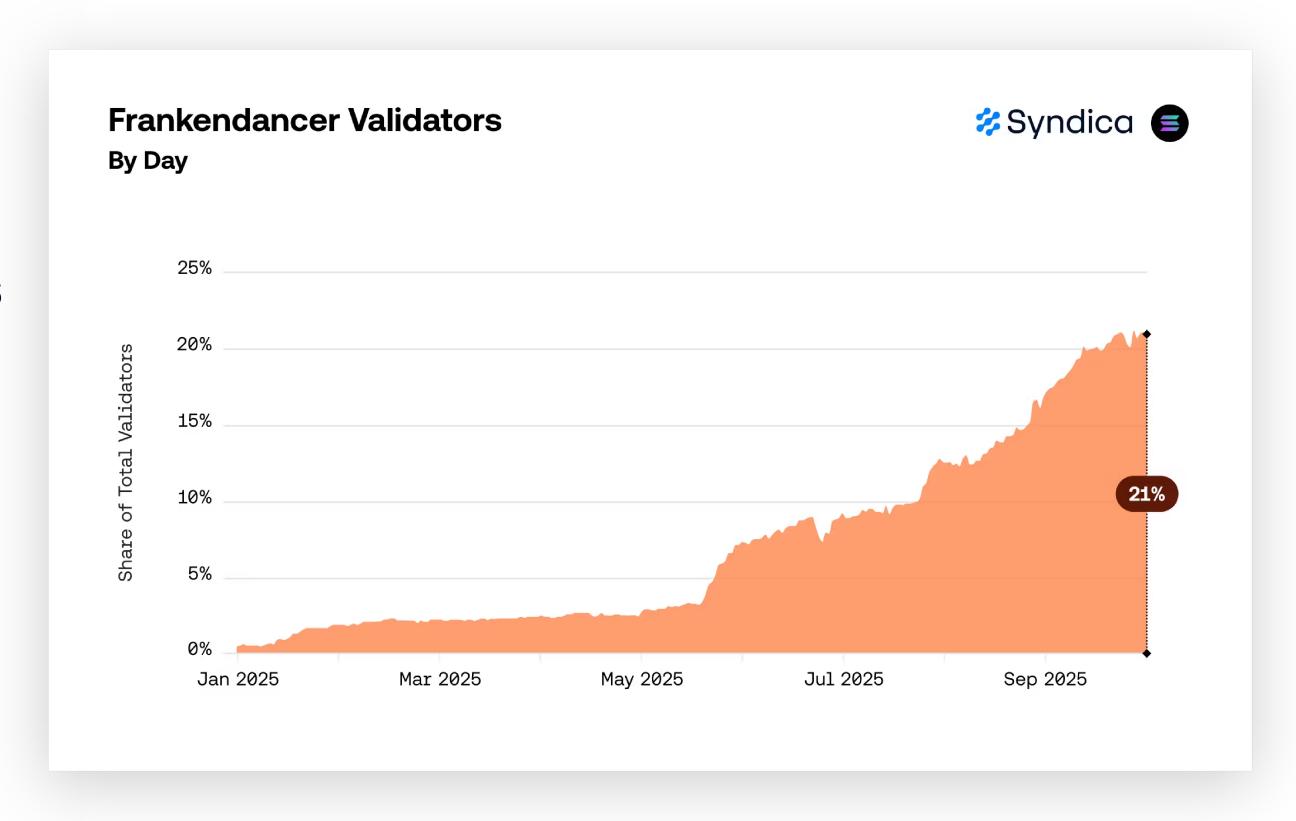


Part II.A Stake



1 in 5 Solana validators now runs Frankendancer.

The number of validators running Frankendancer grew from 6 at the start of the year to 201 by September 30, representing over 20% of all validators.

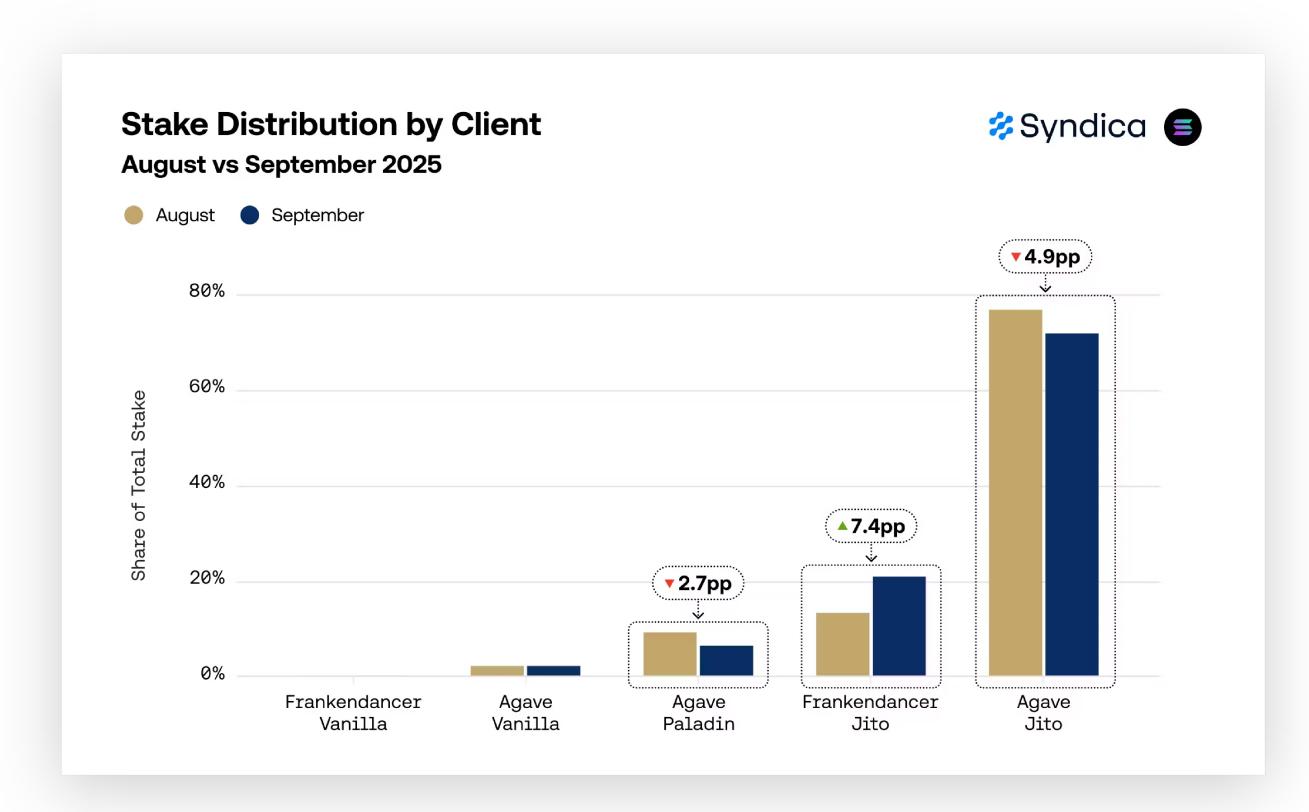




Frankendancer grows past 20% of stake as Agave loses ground.

Frankendancer's share of total stake grew 60% month-over-month and is now equal to one-fifth of total stake.

This growth came at the expense of Agave Jito and Paladin, which fell to 71% and 6% of stake, respectively.





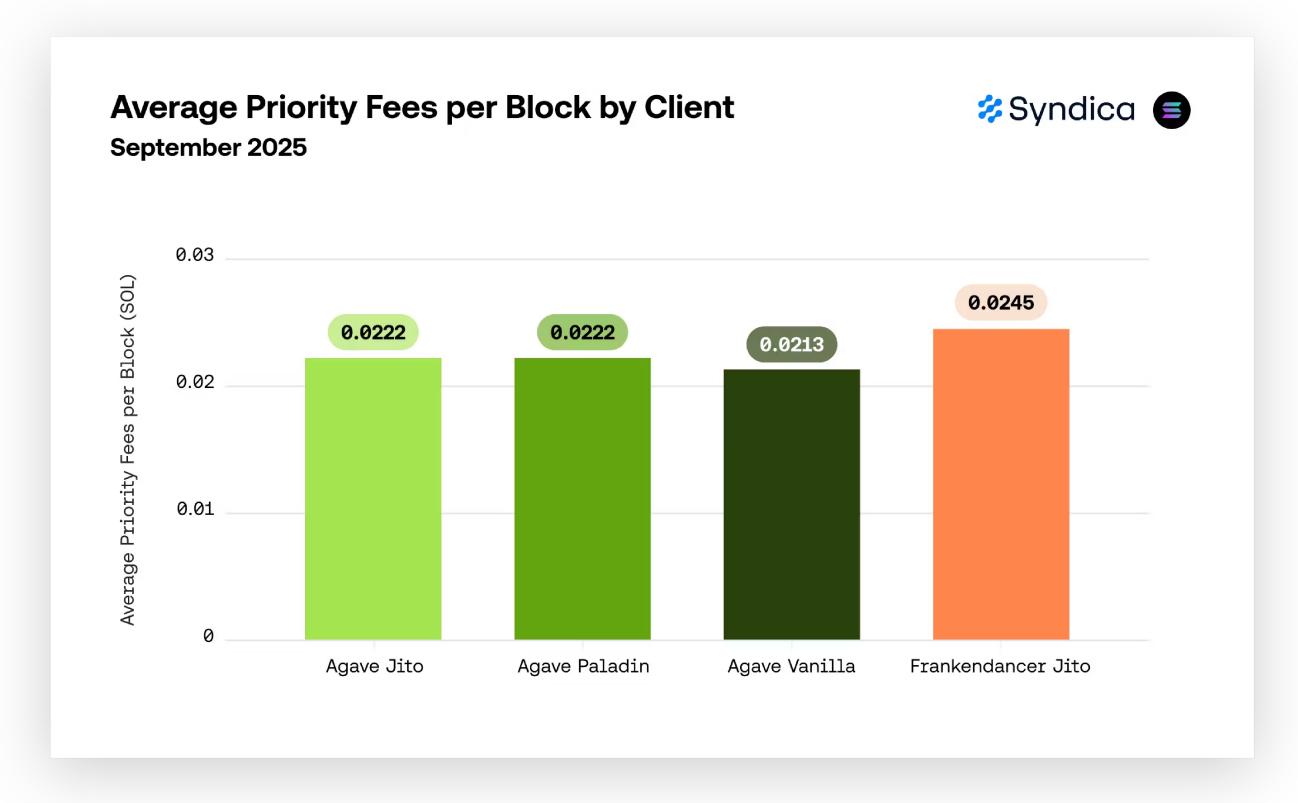
Part II.B Priority Fees



Frankendancer blocks capture more high-value transactions.

Average priority fees per block reveal Frankendancer Jito leading at 0.0245 SOL, about 10% higher than Agave Jito and Paladin.

Higher priority fees indicate Frankendancer blocks contain a greater share of valuable user transactions.



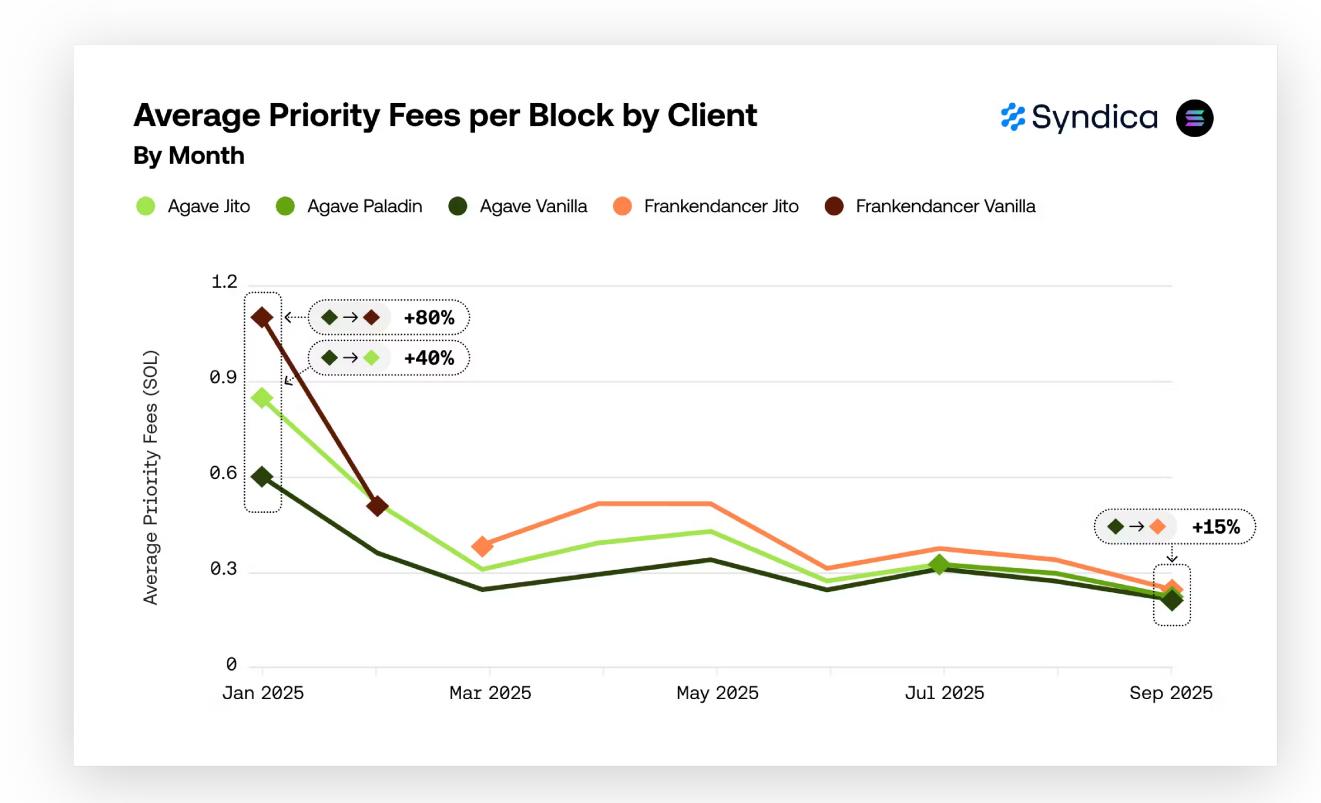


Priority fees converge across clients as activity wanes.

Average fees by client have converged throughout 2025.

January saw Frankendancer Vanilla 80% above Agave Vanilla and Agave Jito 40% above Agave Vanilla.

By September, the range compressed to just 15% between top performer Frankendancer Jito and bottom performer Agave Vanilla.



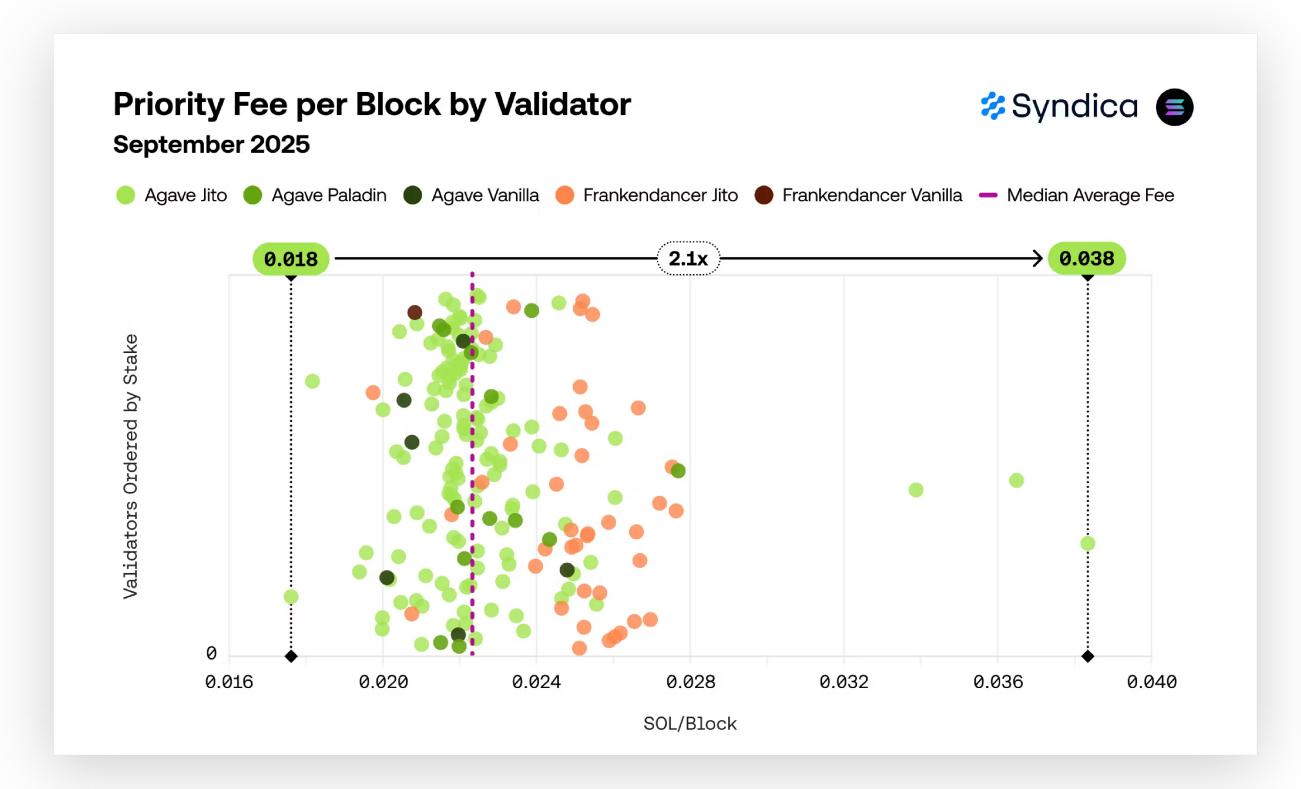


Validator optimizations can eclipse client differences.

Frankendancer Jito validators average higher fees, with 95% exceeding the network median versus only 40% for Agave Jito and Paladin.

However, the widest performance gaps still exist within clients, not between them. All top 3 and bottom 3 performers run Agave Jito, with the best (GUdrZwgT at 0.038 SOL) earning 2.1x the worst (HLXxkmjb at 0.018 SOL).

This suggests Frankendancer provides a baseline advantage, but exceptional validators using any client can outperform.



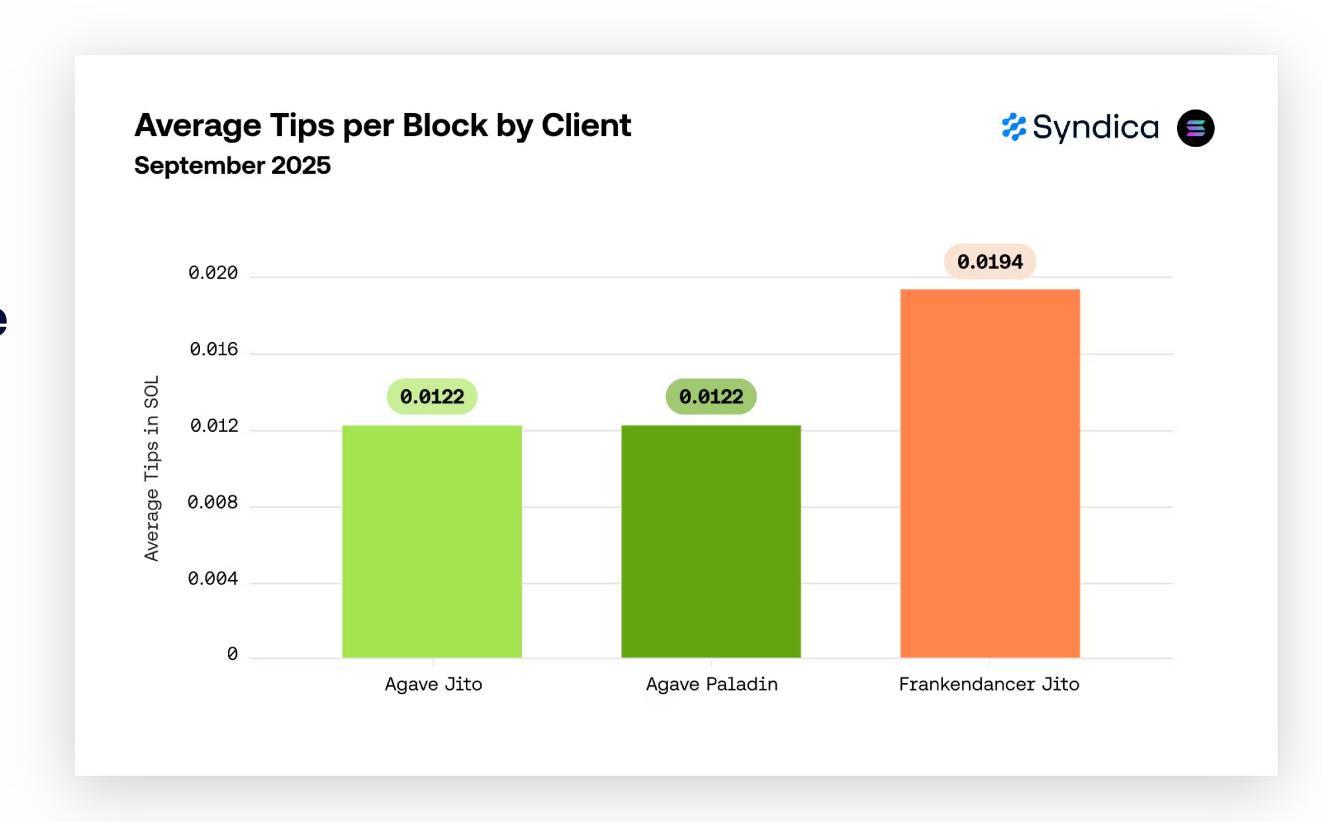


Part II.C Tips



Frankendancer Jito captures 58% more tips per block.

Frankendancer Jito leads average tips per block at 0.0194 SOL, 58% above Agave Jito and Paladin.



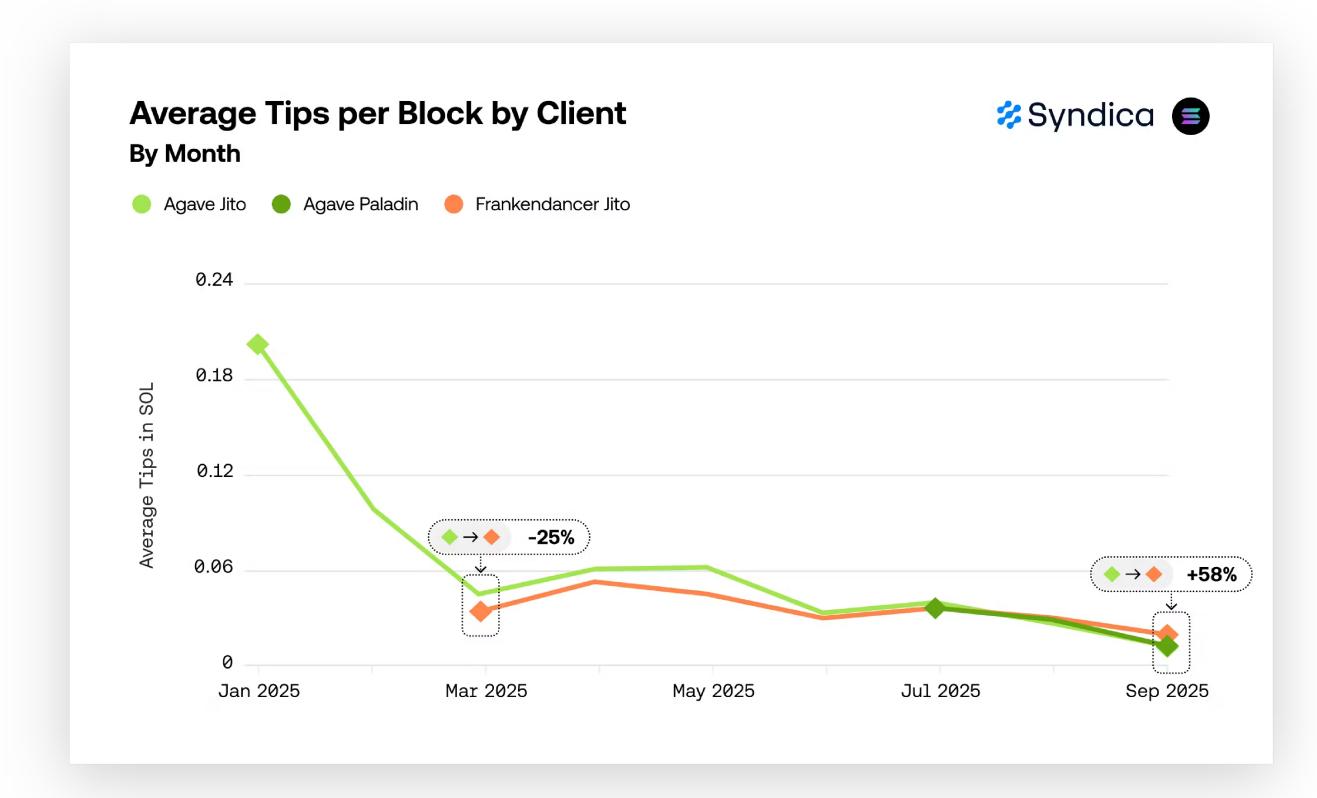


Frankendancer overtakes Agave Jito in tip capture.

Transaction inclusion tips have declined across all clients as activity wanes, but relative performance has shifted.

Frankendancer Jito started 2025 trailing Agave Jito by 25%, but steadily closed the gap through the year. In August, Frankendancer took the lead, exceeding Agave Jito by 13%, then by 58% in September.

Agave Paladin closely follows Agave Jito.

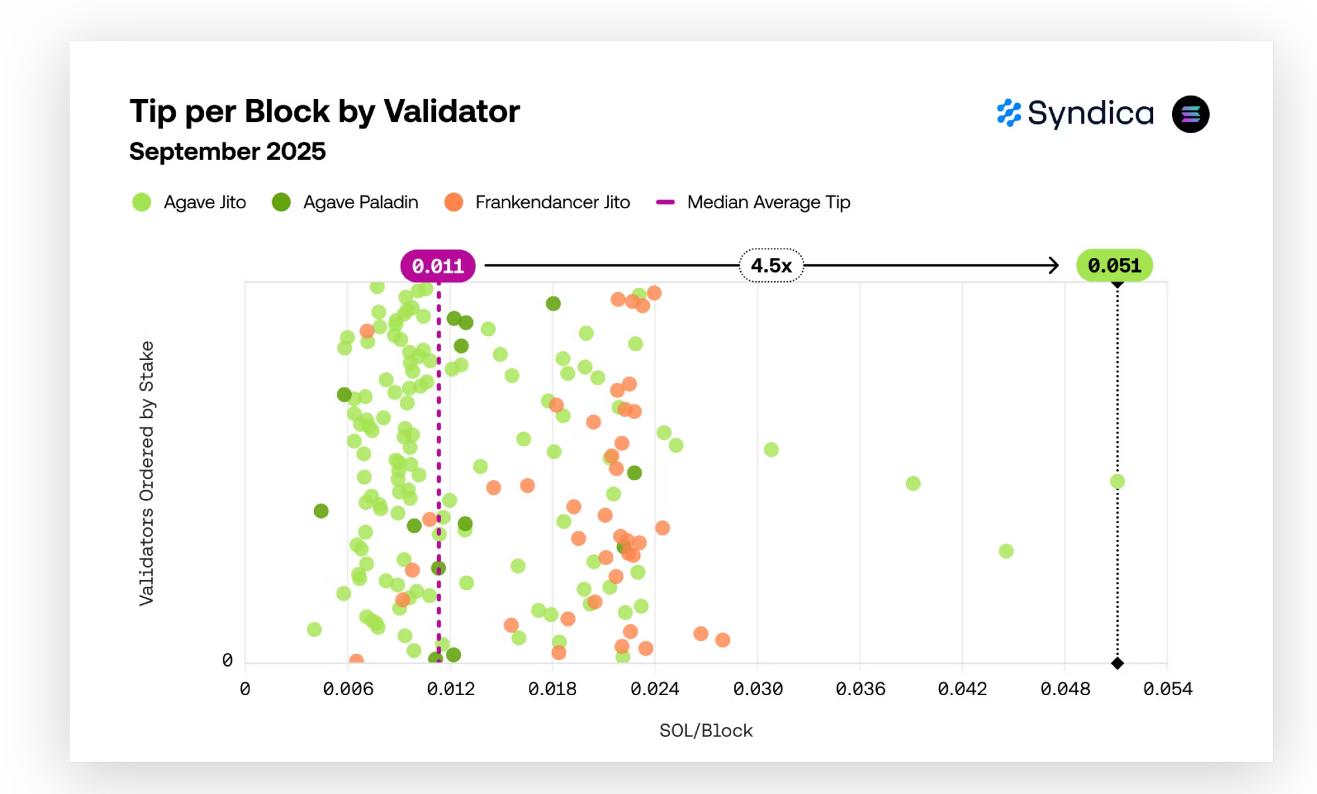




Frankendancer delivers consistent MEV performance across validators.

Individual MEV tips reinforce what we saw with fees: Frankendancer delivers more consistent outperformance (88% above the median vs 37% for Agave Jito), but top validators are running Agave Jito.

The best performer earns 4.5x the median and runs Agave Jito. Just as with fees, Frankendancer provides a baseline advantage while exceptional validators using any client can outperform.





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