Summary

- Filecoin Improvement Proposal (FIP) 0081 adjusts the protocol's initial pledge design to mitigate a potential threat to network consensus security. We consider the tradeoffs of implementing FIP0081 with an immediate and gradual activation.
- We find that a gradual activation requires increases in onboarding and investment flow into the network to maintain the same TVL as for immediate activation. However, gradual activation increases Fil-on-Fil returns (FoFR), creating an extra incentive for attracting investment into the network.
- The decision for which activation schedule to implement depends on stakeholder judgment regarding how SPs/investors will react to a particular FIP0081 activation schedule.
    - If the additional increase in FoFR causes SPs/investors to meet or exceed the minimum increase in inflow required to maintain the same TVL as immediate activation, ramped activation is a net positive.
    - If SPs/investors do not meet the minimum increase in inflow required, but there is enough inflow such that TVL is above the consensus security threshold, then ramped activation can be considered neutral, since it creates the conditions for future upside.
    - If SPs/investors reduce their inflow into the network such that TVL drops below the consensus threshold, then ramped activation is negative.
- Our simulations indicate that if there is no change in onboarding over the next 3Y, all ramped activation schedules result in TVLs exceeding a consensus security threshold of $100M USD, at a hypothetical exchange rate of $3/FIL over the forecasting window (until mid-2026). Additionally, Table 1 indicates that the minimum investment needed to achieve the net positive scenario is on the same order of magnitude as the increase in FoFR offered by each ramped activation. From this, CEL recommends that a ramped activation be adopted.
- Action Items:
    - Stakeholders should use Table 1 and the framework outlined above to determine the appropriate ramped activation schedule.

Table 1: For each activation schedule, the Avg FoFR for the next Year, the Level of additional investment needed to match immediate activation
** This is the average over a 1Y time period.*
*** This is based on the assumption that current onboarding levels stay the same over the forecasting window.*

Activation Schedule	**Avg FoFR***	**Level of additional investment needed to match immediate activation TVL**	**Forecasted Date** of TVL reaching $100M USD @ $3/FIL Consensus Security Threshold**
Status-Quo	27.09%		

with no activation			
5Y	25.31%	1.38%	Mid-2026
2.5Y	25.25%	1.31%	Early-2028
1Y	24.77%	0.81%	Mid-2028
6mo	24.19%	0.35%	Mid-2028
3mo	24.02%	0.23%	> 2028 w/ current forecasts
Immediate Activation	23.9%		

Introduction

Storage Providers on the Filecoin network must post Filecoin as collateral (known as consensus pledge), which serves to incentivize robust storage. Pledge amounts are determined algorithmically every epoch; however, the current pledge design was identified by CryptoEconLab (CEL) as a potential threat to network security. The design flaw results from the way the consensus pledge is computed, which is given by:

$$ConsensusPledge = 0.3 * CircSupply * \frac{SectorQAP}{max(Baseline, NetworkQAP))} \quad [1]$$

where QAP is "Quality Adjusted Power." The denominator contains the term `max(b(t), QAP(t))`, which reduces to `b(t)` when the baseline exceeds QAP. The network's baseline crossed QAP on Dec 17, 2023, and an analysis of how this affects SPs was detailed in this document.

When the baseline exceeds QAP and the denominator in Eq.1 changes to `b(t)`, this results in an exponentially increasing denominator and causes the consensus pledge to decrease exponentially. This cryptoeconomic mechanism was deliberately designed into the network to induce more onboarding by making it cheaper to onboard power if the network was not meeting its baseline target. However, if increased onboarding does not occur, the locked collateral decreases and threatens consensus security. To address this, CEL proposed an adjustment that divided the pledge into two components: simple consensus pledge and baseline consensus pledge. This solution was modeled after the simple minting and baseline minting mechanisms of Filecoin, with a parameter, `gamma`, which controls the proportion of pledge from simple consensus and baseline consensus. To mimic the minting mechanism already in place, the

target gamma value of the proposal is 0.7. For further details, refer to this Filecoin Improvement Proposal (FIP) 0081.

In this document, we consider the tradeoffs of changing the gamma value from 1.0 to 0.7 immediately versus a gradual decrease.

Simulations & Analysis

To simulate the effect of the various gamma schedules on the network, we use a mechanistic model of the Filecoin Network, MechaFIL. Fig. 1 shows the various gamma schedules that are analyzed. We consider the network state in each potential ramp schedule to determine whether a ramped activation is better than an immediate activation. A longer activation period results in a lower pledge for a longer time, while a shorter activation period will result in a lower pledge for less time. For further details, refer to this Filecoin Improvement Proposal (FIP) 0081.

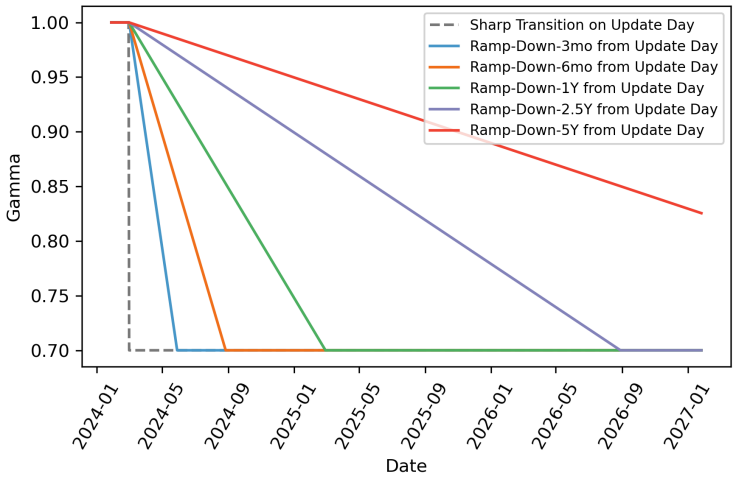


Fig 1: FIP0081 activation schedules tested

Fig. 2 shows the effect of the various FIP activation schedules on the network locked (TVL), assuming that median onboarding, renewals, and Fil+ rates remain the same throughout the forecast period. We observe that even though the network maintains the same power, TVL is lower in the longer ramped cases than in the shorter ramped cases. This is because a lower pledge is needed to onboard the same amount of power in the longer ramped case. Fig. 3 shows the other perspective: a longer ramp results in higher Fil-on-Fil returns (FoFR), incentivizing SPs to onboard more power. This is the central tradeoff that must be considered when deciding on FIP0081's activation schedule: *Does the increase in FoFR created by the ramped activation create a strong enough incentive for SPs to onboard the minimum necessary increase in onboarding to maintain TVL, compared to the immediate activation?*

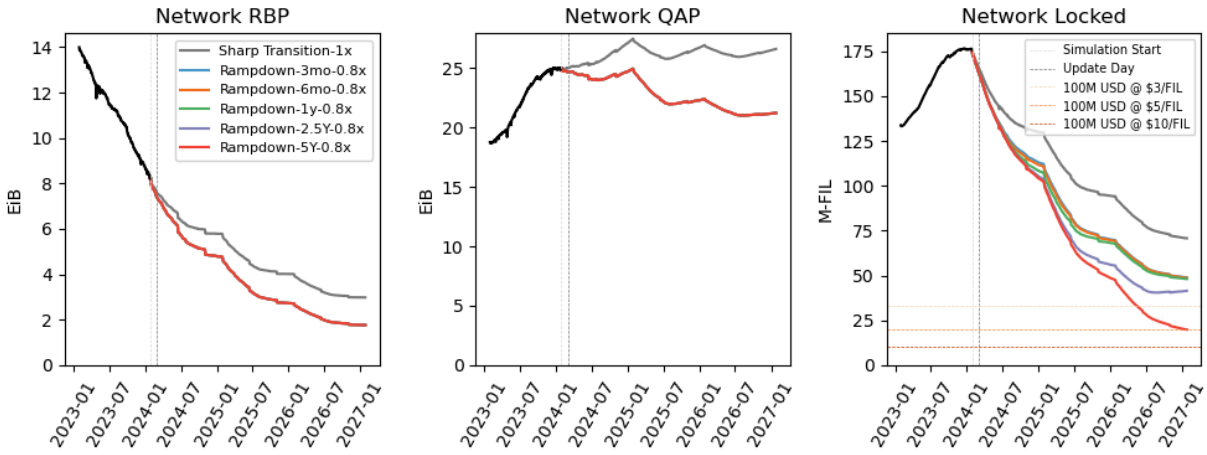


Fig 2: Network state where the FIP is immediately activated (shown in grey) and various ramp schedules. Observe that network locked (TVL) is decreased for ramped activations when compared to the immediate activation.

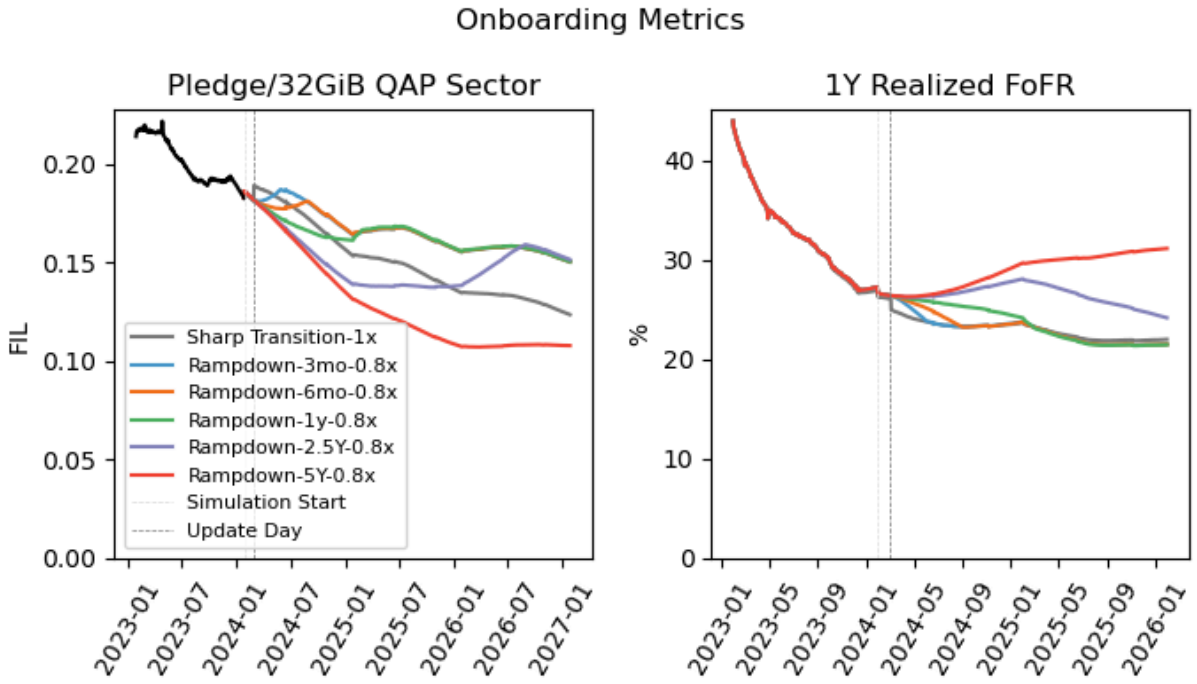


Fig 3: Pledge and Fil-on-Fil returns for the immediate and ramped activation schedules.

Given the tradeoff, we seek to answer the following question: What is the increase in onboarding/investment needed to maintain the same TVL for a particular ramp activation schedule versus immediate activation?

To find out, we re-run the previous simulation but scale onboarding by the amount necessary to match TVL. Fig 4B verifies that the scaling factors applied are accurate because TVL is

matched across all ramp configurations. Fig 4A shows the forecasted network power. A longer ramp results in a larger Network QAP if TVL is invariant. This is expected since a longer ramp results in a lower pledge, and thus more power must be onboarded to catch up to the reference TVL. Fig 4D shows the difference in the expected FoFR for each ramped schedule, *taking into account the increased network size that results from maintaining TVL invariance*.

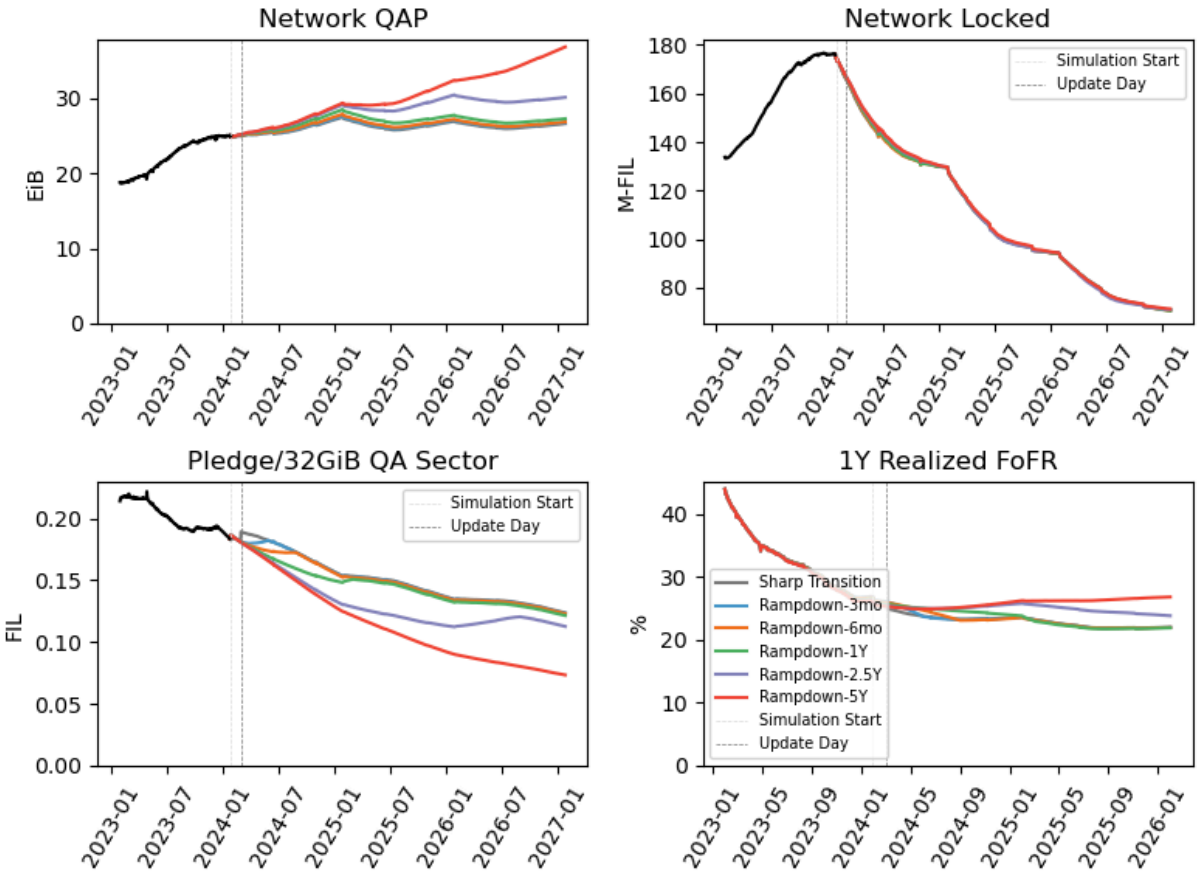


Fig 4: Network state when keeping TVL invariant

Fig 5 and 6 summarize the central tradeoff presented for each ramped case. The blue bars represent the additional average FoFR for each case compared to immediate activation. The orange bars show the additional investment/power needed to match TVL. Note that both Fig 5 and 6 correspond to the same inflow required by the network, but show the two relevant perspectives: power and investment. Summaries are computed by averaging over the forecasting period.

From Fig 5 and 6, the question to be considered is of the form: for a particular ramp schedule, how likely is it that the network will observe the necessary X% (Y%) increase in onboarding (investment), given that FoFR is expected to increase by Z%. For example, considering the 5Y ramp schedule, how likely is it that the network will experience a 38.3% (1.4%) increase in

onboarding (investment), given that the 5Y ramped schedule increases FoFR on average by 6.01% over the next year?

The simulation establishes the bounds that must be met, but the actual investment/onboarding levels can depend on many factors outside of the control of the network, including macroeconomic climate, Web3 sentiment, and alternative investment vehicles that may be available to investors.

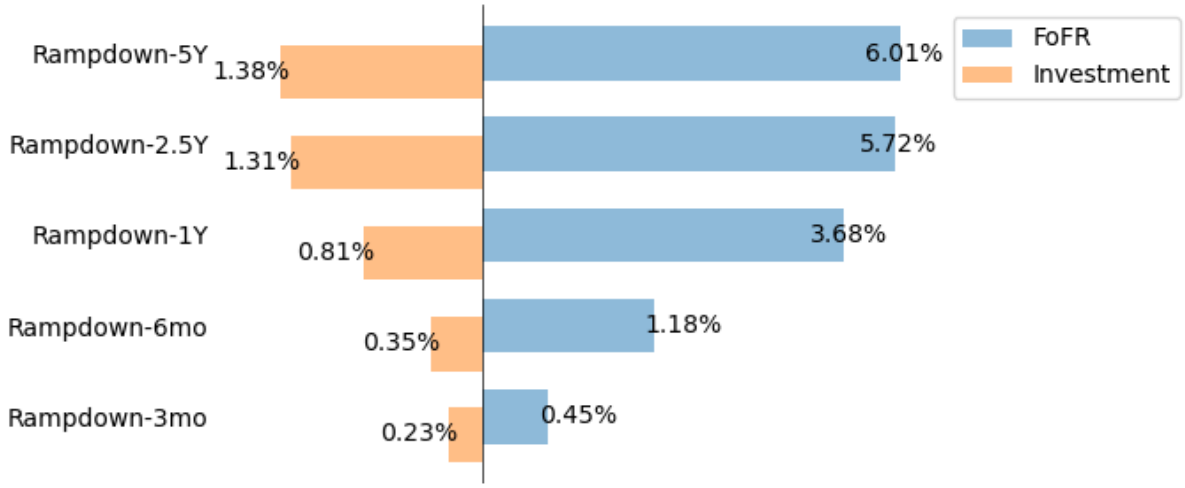


Fig 5: The blue bars show the average increase in FoFR over 1Y afforded by the corresponding activation schedule. The orange bars show the necessary increase in investment inflow over 1Y required to maintain TVL invariance to the sharp implementation case.

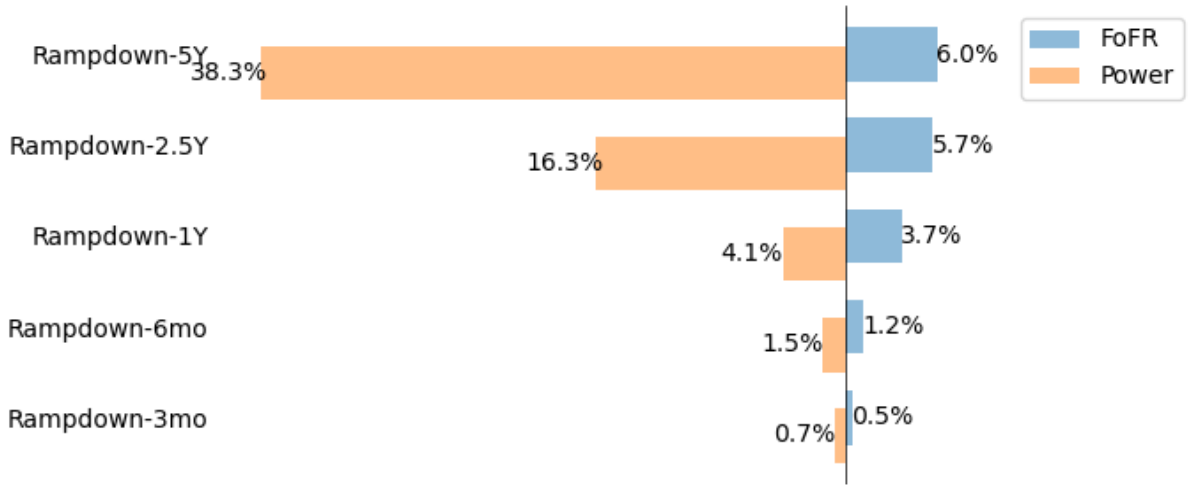


Fig 6: The blue bars show the average increase in FoFR afforded by the corresponding activation schedule. The orange bars show the increase in onboarding necessary to maintain TVL invariance to the sharp implementation case.

Conclusion

In this note, we developed a framework for determining how to activate FIP0081, whether through a ramped activation or immediately. We primarily assess the costs and benefits from a TVL perspective since the purpose of FIP0081 is to protect consensus security. The following bullet points summarize how to think about whether a particular activation schedule is beneficial:

- Ramped activation is beneficial if the additional increase in FoFR offered by the ramped activation will incentivize SPs/investors to onboard at least the minimum amount to maintain TVL as the immediate activation case. This is because if this case actualizes, the network has the same TVL as with immediate activation but more power; a win-win for the network.
- Ramped activation can be considered neutral if the additional increase in FoFR offered by the ramped activation does not incentivize SPs/investors to maintain TVL compared to the immediate activation case but enough to exceed network consensus security thresholds. In this case, the network will have less TVL and may maintain or reduce in power but still contain enough TVL to maintain security. This is labeled neutral because the increased FoFR incentive still exists, and future changes to investor sentiment can be harnessed with the increased incentives, enabling a pathway for the network to rebound.
- Ramped activation is negative if TVL drops below security thresholds. This can occur if the community does not take advantage of the increased incentives or if divesting from the network occurs at a sustained rate.

Fig 4 indicates that small increases in onboarding/investment are needed to maintain TVL. Additionally, Fig 1 indicates that even if those increases are not realized and users do not respond to the increased incentives, network TVL is maintained until mid-2026 for a conservative scenario where FIL can be exchanged for $3 and a 5Y ramped schedule. For this reason, CEL's judgement is that the risks associated with a ramped schedule are outweighed by the potential upside, and it can be recommended to use a ramped activation. Other stakeholders are encouraged to assess the presented information and weigh in on the desired activation schedule.

References

- MechaFIL
- Simulation Notebook

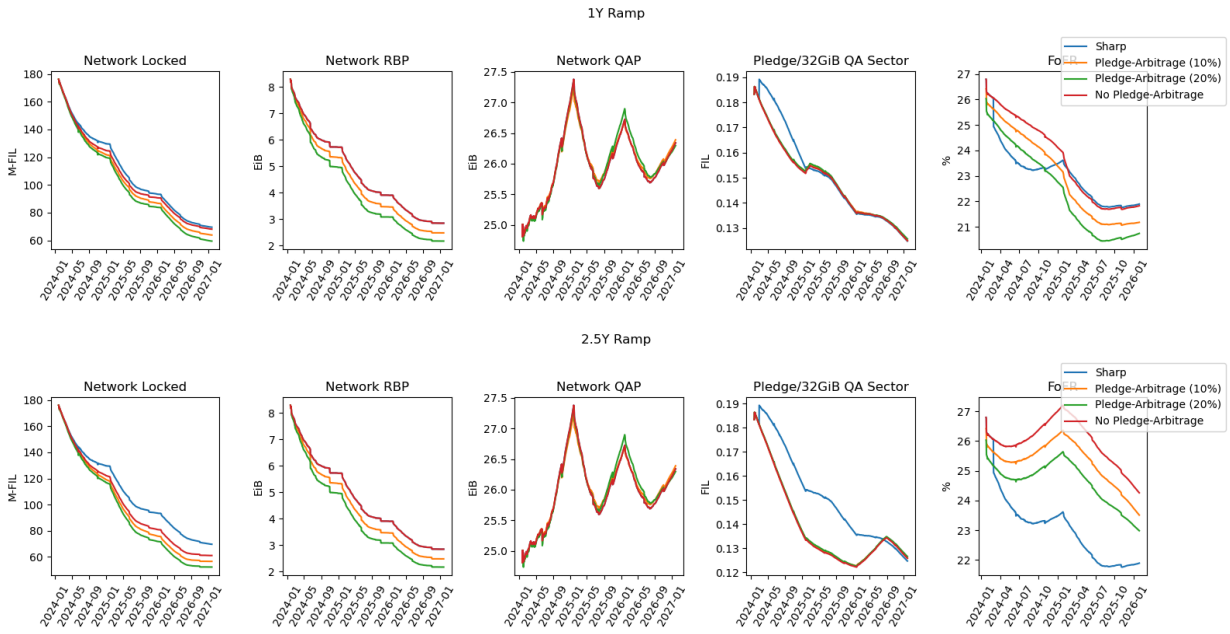
Appendices

Appendix A - Are there incentives to engage in Pledge Arbitrage?

In this Appendix, we discuss a separate but related question of whether there are incentives to arbitrage pledge. Pledge arbitrage is when SPs choose to expire and renew their sectors for cheaper pledge rather than renewing them.

If an SP engages in pledge arbitrage, they will renew less power, and onboard the same amount of power that would have been renewed. Because pledge is decreasing, the same amount of new power onboarded results in less TVL. Assuming that SPs decide to onboard the same amount of FIL+ as the current rates (this is a valid assumption, considering the current economic climate and incentive structures in Filecoin), this will result in a lower network RBP. Lower RBP means less returns per sector, which then implies less FoFR for engaging in pledge arbitrage.

We simulate this by taking each pledge arbitrage hypothetical and scaling such that the NetworkQAP is maintained. The FoFR trajectories in Fig 5 indicate that no-pledge arbitrage results in higher than engaging in pledge arbitrage. Note that this is dependent on the Fil+ rate.



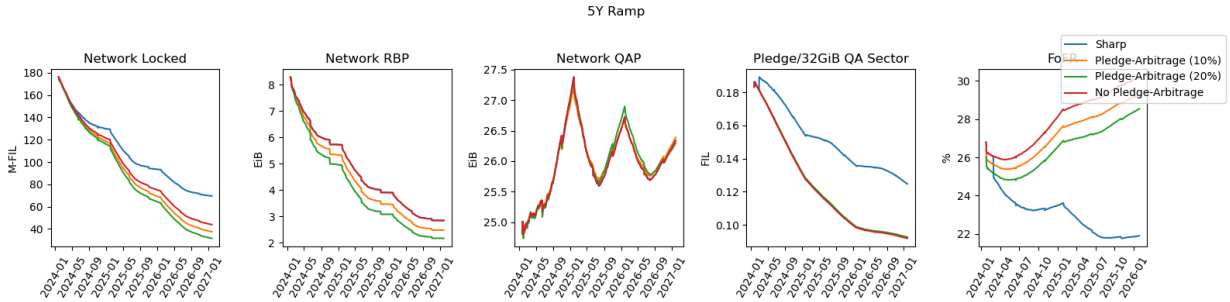


Fig 6: Comparing FoFR for Pledge Arbitrage and No Pledge Arbitrage cases for 1Y, 2.5Y and 5Y ramp cases, if considering power invariance.

[See here for additional notes on pledge arbitrage.]