Minimum Viable Issuance

Introduction

1. I consider minimum viable issuance to be an important pledge to the regular Ethereum user. Staking should secure Ethereum, but not become an inflation tax, degrading utility and liquidity while generating monopolistic hazard. A thread on staking economics:

2. This thread is 118 tweets long so I formatted it into a post for those who may prefer that format. I am also preparing a series of follow-up threads, where I will present my vision for how we can achieve MVI under an autonomous issuance policy.

3. Before I start I would like to thank Barnabé Monnot, Caspar Schwarz-Schilling, Francesco D'Amato, Davide Crapis, Julian Ma, Thomas Thiery, Ansgar Dietrichs and Justin Drake for fruitful discussions around this thread and the overall topic.

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4. Ethereum is constantly growing and may very well power the global financial system one day. We must assume that the "regular user" will know about as much about the inner workings of Ethereum as regular people know about the current financial system.

5. Certainly, we cannot assume that the regular user will be driven by the sort of ideological dedication that once led to the creation of Ethereum in the first place. Our job is simply to ensure that the correct incentives are in place so that Ethereum can grow unencumbered.

6. An important design principle present from Ethereum's inception is "minimum viable issuance" (MVI), the idea that the protocol should not issue more ether than what is strictly needed for security. The principle is sound both under proof of work (PoW) and proof of stake (PoS).

7. Under PoW, MVI was applied to prevent miners from extracting an excessive inflation tax on regular users. Thus, the block rewards were reduced from 5 ETH to 3 ETH and finally 2 ETH.

8. Under PoS, MVI should also be upheld to not extract an excessive inflation tax on regular users, who should not need to concern themselves with the intricacies of staking to avoid getting their savings eroded, or to avoid supporting a censored or censoring validator set, etc.

9. Fundamentally, MVI is then the issuance level that keeps the deposit ratio d (the proportion of all ETH that is staked) sufficiently high, but not higher. I will in this thread try to outline why issuance beyond the "minimum viable" degrades utility for Ethereum.

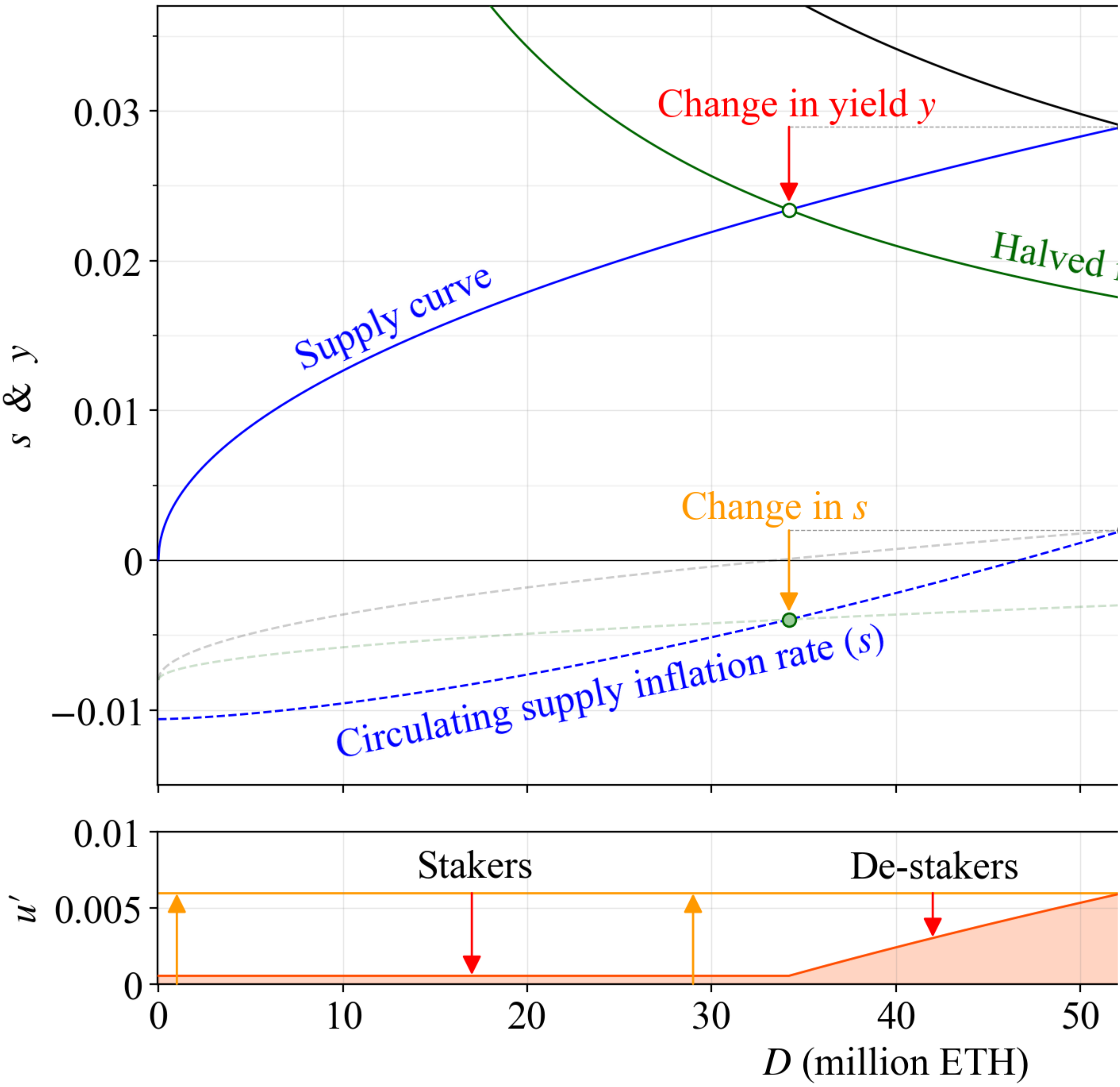
Benefits of MVI to user utility

10. There are various opportunity costs to staking for the individual. It requires resources, dedication, and technical knowledge, or trust in third parties, while reducing liquidity. Liquid staking tokens (LSTs) are less reliable and less desirable as money or collateral.

11. Therefore, individuals want to be rewarded to stake. Define their *reservation yield* as the lowest yield at which they are willing to stake using their optimum staking modality. Ethereum's (inverse) supply curve then emerges from prospective ether holders' reservation yields.

12. A holder's reservation yield can be characterized as the "indifference point" where they derive as much utility from staking as from not staking. This implies that a reduction in issuance can improve utility for everyone, even stakers, as long as Ethereum is viably secure.

13. Consider a hypothetical supply curve (blue) with a yield elasticity of supply of 2. In this example, I have set it to reach a yield of 2 % at a deposit size D of 25 million ETH, i.e., the "marginal staker" at 25 million ETH staked would have a reservation yield of 2 %.



14. In reality, the supply curve is a rather complex phenomenon, and we have not yet reached an equilibrium at which it can be anchored, but we will begin with this curve as a simple and rather realistic scenario. We will also ignore complexities of compounding variables.

15. The burn rate is set to $b=0.008$. It is the yearly burned ETH since The Merge as a proportion of supply. But it is not critical since we focus on shifts in the medium-run equilibrium (circles) between the supply of stake and Ethereum's demand for stake (implied by its yield).

16. [Realized extractable value]() (REV) (a little over 300 000 ETH/year) has been added to protocol issuance to form the black demand curve (current policy) and green demand curve (halved issuance by reducing the base reward factor F from 64 to 32).

17. Halving issuance reduces the equilibrium yield y (red arrow). This reduces the issuance yield $y_i = y - y_v$ (where y_v is the yield from REV) and therefore the issuance rate $i = y_id$ and thus the circulating supply inflation rate $s = i - b$ (orange arrow).

18. The attainable change P to someone's proportion of all ETH after one year depends on s and each holder's yield y according to

$$ P = \frac{1+y}{1+s} - 1.$$

The proportionality between the current issuance policy giving P_1 and halved issuance giving P_2 is

$$ P' = \frac{1+P_2}{1+P_1} - 1.$$

19. Define the associated change in cardinal utility as $u' = P'$, but use the individual reservation yield for those who stop staking when computing P_2. Below that yield, they do not wish to stake anyway, so they suffer no additional loss in utility as the yield falls further.

20. As shown in the bottom pane, everyone will under this definition derive a higher utility at the new equilibrium. Stakers see a reduction in yield but the reduction in the supply inflation rate is bigger and this allows them to attain a larger proportion of all ETH ex post.

21. Non-stakers will of course clearly be better off, since the only difference to them is that the ether issued to stakers has been reduced. The de-stakers are the only participants who attain a lower proportion of the circulating ETH at the new equilibrium.

22. Disregarding frictions, they are however still implicitly better off due to the improved utility. For example, the marginal staker at the old equilibrium was indifferent to staking anyway and can thus de-stake and account for the full utility gain of reduced supply inflation.

23. Other de-stakers find themselves in between, still gaining from reduced inflation, but taking some losses in yield until they become indifferent to staking and de-stake. We have illustrated that from a utility perspective, issuance policy is not a zero-sum game.

24. Additionally, all token holders generally benefit from utility gains of any one group. In my next thread, we will take a closer look at how the slope of the supply curve affects the outcome, and then further relate d to security. But the initial message stays the same.

25. Everyone can gain from MVI as long as they own the underlying ether. This excludes CEXes and other staking service providers (SSPs) that profit from staking fees. They won't benefit from the reduction in supply inflation and want to keep the yield high to keep their cut high.

26. But issuance above MVI forces unwilling stakers to suffer degraded utility when staking or degraded economic consequences when not staking. And even willing stakers are worse off under realistic supply curves. Note that the example did not even account for tax effects.

27. A PoS cryptocurrency with a 5 % yield where everyone stakes and the average tax on staking yield is 20 % will dissipate 1 % of its market cap to taxes every year. That is higher than what Bitcoin will dissipate to miners after the next halving.

28. The argument need not necessarily hinge on how users feel about taxation levels or how staking yield should be interpreted. We may still conclude that Ethereum remains more neutral with regard to variations in taxation policies between nation-states by enforcing MVI.

29. Proof of stake arguably requires lower rewards to achieve the same level of security as PoW, and it is important to fully take advantage of this to maximize user utility. For example, the total rewards at a 2 % yield and 25 million staked is $Y = 0.02 \times25 = 0.5$ million ETH.

30. The "reward rate" that maintains this solid security is then around $r = Y/S = 0.4$ %, which is impressively low. We maximize utility for users by fully taking advantage of this. A potential equilibrium with the current issuance policy is instead indicated by a black circle.

31. It is around 3 % yield and 50 million ETH staked, giving $Y = 1.5$ million ETH/year. The difference in rewards, 1 million ETH every year (over a billion dollars at the current token price), could be rewarded to Ethereum's users by not diluting token holders.

32. A 15 % staking fee extracted on average across stake would provide CEXes and SSPs with around 250 million dollars of surplus profit relative to MVI every year. Some will pass to shareholders of corporations and some may be spent lobbying for keeping yield above MVI forever.

33. This thread will now focus on the current macro discourse, but we must always start from user utility. By straying from user utility to pass around excessive "yield"—which is always an inflation tax on regular users—we risk ruining the very foundation of Ethereum's economy.

Benefits of MVI from a macro perspective

34. I often argue that it is desirable that the ether permeates the ecosystem. In the case of L2s, bridged ether binds the L1 and L2 together and provides users on the L2 with outside money, improving their financial security.

35. If you create a system where users must rely on some opinionated derivative of the ether token as their money to avoid an inflation tax, the entire ecosystem can more easily be corrupted.

36. Consider for example the situation when users who are unable to stake instead supply their ETH to organizations running validators for them (SSPs). These organizations can issue LSTs as collateral, which is to be used across Ethereum.

37. If the protocol does not operate under MVI, but at a higher deposit ratio, one or a few LSTs may overtake as money in the Ethereum ecosystem, embedding themselves across every layer and application. What would the effects of this be?

38. First of all, the positive network externality that the money function brings could enable an LST to retain a dominating position while its SSP provides an otherwise worse service than competitors (e.g., by taking a higher fee or just offering poorer risk-adjusted rewards).

39. I am applying the term "money" or "money function" here very loosely, referring to a Schelling point for financial interactions: say the medium of exchange when paying for goods and services, a store of value, or a standard of deferred payment across globalized DeFi, etc.

40. Secondly—and most importantly—LST holders and any application or user who needs the LST to preserve its value will develop a shared destiny with both the LST and ultimately the LST issuing organization (the SSP).

41. In the case of a mistake or misdeed, which may also take place at any mechanisms designed to regulate the organization (such as smart contracts, on-chain governance, or government regulations), Ethereum's social layer may not have the capacity for appropriate (non) measures.

42. It would require Ethereum to destroy a large part of itself. The affected users may prefer to reinterpret the mistake or misdeed as something entirely different. Once you become the money of Ethereum, you to some extent *become* the social layer.

43. The money function is in this way a Ryanian "stratum for cartelization" that acts one layer above the various strata (e.g., MEV extraction, block-timing manipulation) that Ryan explores in his post on the risks of LSTs.

44. We are no longer only concerning ourselves with the proportion of the staked ETH under an LST, but the proportion of the total ETH under an LST. The corrupted institution(s) correspondingly also sits one layer above the consensus mechanism, namely the social layer.

45. It became apparent with The DAO that if the proportion of the total circulating supply affected by an outcome grows sufficiently large, then the "social layer" may waver on its commitment to the underlying intended consensus process.

46. If the community can no longer effectively intervene in the event of for example a 51 % liveness attack, then risk mitigation in the form of the warning system discussed by Buterin may not be effective.

47. The consensus mechanism has in this case through derivatives grown so large and interconnected that it has overloaded its ultimate arbitrator, the social consensus mechanism. It is a special and sort of inverted case of issues Buterin warned about.

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48. Now consider the difference to the situation under MVI. First of all, each LST will have a tougher competition with the non-staked ether token. The ability to monopolize the money function and then take out outsized fees or offer a more risky product is thus reduced.

49. Secondly, the social layer will remain natively bound to Ethereum and the ether, not an outside organization and its issued derivative of the ether token. Keeping the deposit ratio sufficiently low through MVI therefore alters participants' risk calculation.

50. The principal—agent problem (PAP) of delegating stake to a dominant LST can then be priced more accurately because the deposit ratio is too low for a moral hazard to develop. No LST will grow "too big to fail" in the eyes of the Ethereum social layer.

51. This pricing will reflect the fact that the agent acting on behalf of the delegator (or any party able to inject themselves into that relationship) gains better opportunities to degrade consensus for its own profit the larger proportion of the stake it controls.

52. The delegating staker must always contemplate what security guarantees it has (e.g., the staking agent's or injecting parties' own value at risk), knowing that it may lose everything if the worst-case scenario ever comes to pass.

53. Taking outright dominance as money in Ethereum off the table, and assuming MVI under which the deposit ratio has grown to a utility-maximizing size, bigger SSPs could very well find non-monopolizing strategies more profitable (i.e., an increase in fees).

54. That is just a comment relating to the present. Importantly however, it reflects the fact that for each "stratum of cartelization" that we are able to remove, the value proposition of secure and value-aligned SSPs increases in relative terms.

55. One important step towards MVI is MEV burn, which may also have the potential to remove a more important "stratum of cartelization" than the money function. MEV burn helps by reducing variance in rewards for solo stakers, which increases if the issuance yield is reduced.

56. It also brings improved precision when targeting MVI, because it removes a source of rewards that may vary over time in ways that cannot be predicted beforehand. As discussed at the end of the thread, MEV burn is however still insufficient on its own for MVI in the long run.

57. Notably, various remedies to some aspects of the PAP of delegated staking may very well be adopted in the future (i.e., one-shot signatures). But the fundamental issues of trust, monopoly incentives and the ability for censorship may be hard to escape.

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58. Another benefit of MVI is that it improves the conditions for (solo) staking, due to the direct relationship between deposit size, validator quantity and validator size. If the deposit size changes, the validator size or the validator quantity (network load) will also change.

59. The effect spreads throughout the whole protocol design space and will influence any objectives that may be substituted for a higher or lower network load such as parameters relating to variable validator balances.

60. This is a fundamental property of the current consensus mechanism. If the issuance policy leads to $d = 0.6$ at the medium-run equilibrium instead of $d = 0.2$, then, to retain the same network load, three times as much ether will be required for solo staking, ceteris paribus.

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61. Returning to the essentials, the most important benefit of MVI in my opinion is its ability to provide utility to the regular user. Ethereum is in a unique position to make a native cryptocurrency global money, and I would argue that it is a chance worth pursuing.

62. When nation-states enforce price inflation by growing their monetary base, they *assume control* over regular people's intertemporal choice, and *assume* that such *control* is viable in a digitalizing and globalizing world.

63. Ethereum should not assume control over regular people, nor force them to expend energy economizing on liquidity. We should give them maximum ease of use and utility of their Ethereum money. The "risk-free rate" in Ethereum is simply holding (and transacting in) ETH.

Addressing potential concerns of MVI

64. Having given an account of the potential benefits of MVI, the second part will address some suggested drawbacks. These include reduced economic security and the notion that delegated staking will overtake all solo staking if we were to lower the yield.

65. When it comes to the first point, this is indeed true in the sense that a higher deposit ratio will indeed force an attacker to expend much higher resources, for example, to revert finality. That is not something to take lightly.

66. We are not aiming for "minimum issuance". We must always ensure that it is "viable". Buterin offered some intuition regarding how expensive a 51 % attack on Ethereum should be.

67. We may also consider the almost 14 million ETH securing Ethereum at The Merge to be a "*revealed preference*" of a deposit size that the ecosystem finds sufficiently secure under the current consensus mechanism (for Sybil resistance and not just super-committee accountability).

68. At the same time, it is certainly nice to have a substantial margin, and the current deposit ratio ($d \approx 0.2$) may offer a meaningful improvement over the deposit ratio at The Merge

($d \approx 0.1$) from an anti-Sybil perspective.

69. However, we are now arguably at a level where the marginal increase in security from adding another validator brings less utility than the utility loss to users

70. Tweet 14 illustrated how an issuance policy that pushes users over their staking indifference point may degrade utility for everyone if the protocol is already secure. We can thus simply add utility afforded by security as a variable to the equation.

71. As will be explored in subsequent threads, the slope of the reward curve cannot be too steep, which is why we may wish to operate at some distance to the revealed-preference point, and ultimately can determine d from a probabilistic analysis of staking supply and demand.

72. Some may suggest that delegated staking somehow makes resource allocation for an attack easy, it is only security "on paper". But by keeping all stake slashable and removing moral hazard (via MVI), delegators must be very careful when delegating stake, as previously outlined.

73. In that setup, the market decides a capitalization ratio that is appropriate for staking operators and also prices the risks of staking. Ethereum is instead responsible for punishing misbehavior and upholding the value of ETH relative to the value that it secures.

74. By ensuring that the ETH token permeates the real economy and that all consensus participants have something real at stake, we attach a price to an attack that is harder to circumvent through financial engineering.

75. I mention this because there are (by all means interesting) alternatives discussed, wherein Ethereum involves itself with the delegation process and where delegators have nothing at stake. The risks when contributing to a degraded consensus are then much lower for delegators.

76. Or at least so it would seem. The nothing-at-stake delegator may be surprised by how the social layer decides to evaluate their delegation and the perceived damage they have caused in the event that Ethereum forks and/or must be rescued by social intervention.

77. I am here again back to Buterin's request to not overload the consensus. My point and a theme of this thread is that when the proportion of ether involved in the consensus process is very high, everyone is roped in, and it may be impossible to achieve a "neutral" outcome.

78. The conclusion to the first concern is thus that d under MVI must remain sufficiently large to ensure security, that delegation indeed reduces that security somewhat, but that parties will try to account for risks and delegate wisely as long as their stake is at risk.

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79. The issue of retaining solo stakers is certainly a complex conundrum. Economies of scale are hard to design away and we have not focused enough on liquidity in staking. There are however some nuances to current arguments, more in favor of MVI, that I wish to bring forward.

80. Ethereum's solo home stakers have certain costs when staking. They have paid a large part upfront, including knowledge acquisition. They also incur variable costs for broadband, troubleshooting time and risks of outage, etc.

81. Many of Ethereum's SSPs have also incurred significant costs when designing their service and incur other types of operating costs that the solo staker need not worry about. However, they rely on economies of scale to reduce the average costs of operating a validator.

82. We must assume that SSPs seek to maximize profits and can ponder over what their fees may be under different equilibria. How does the economy of scale differ between $d=0.2$ and $d=0.6$? It seems reasonable to assume that SSPs have much lower average costs at $d=0.6$.

83. Recall also that at $d=0.2$, solo stakers may be able to run three times smaller validators than at $d=0.6$. There is probably a difference between having the smallest validators be 32 ETH and 96 ETH (or 11 ETH - 32 ETH) in terms of the proportion of solo stakers we can attract.

84. Thus, not only will an issuance policy leading to a higher d force solo stakers to own more ether at the same network load, they must also compete with SSPs able to take lower fees. While fees will be set according to market strategies, average costs should ultimately matter.

85. In the event that we reduce the yield, SSPs would hopefully need to increase fees to properly cover and amortize costs. The delegating staker's costs are variable, including the PAP and fees. They can walk away from increased fees with very little friction.

86. The argument that solo stakers will leave (before delegating stakers) with a reduction in yield is something to take seriously. But since current home stakers have already incurred fixed costs, their individual yield elasticity of supply in the present need not be very high.

87. However, should we reduce the yield so much that solo home staking becomes unviable (including for new entrants), their lower elasticity in the short run will not help. *If* we want to keep solo staking, there is a lower bound to the total staking yield that we cannot go below.

88. Say that total costs (denominated in ETH) of solo home staking are C and add some other considerations such as the yearly risks R to funds when staking. Then the yield must stay above $y>C/32+R$ by some reasonable margin, even in the event that re-staking brings liquidity.

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89. Here I also wish to address the impact of DeFi yield. All stakers receive yield that is endogenous to staking y. This "endogenous yield" derives from issuance, MEV and priority fees. Some may also receive "exogenous yield" y_c outside of the consensus mechanism.

90. It is not possible to simply sum $y+y_c$ for the LST holder and conclude that the LST holder always gains against the solo staker whenever y falls. Presumably, the ETH token brings a higher utility than the LST (when disregarding its endogenous yield).

91. The delegating staker must weigh $y(1-f)$, where f is the percentage fee, against risks/costs including the PAP and the inherent downsides of the LST relative to native ETH, and will decide to stake only if $y(1-f)$ (and not $y+y_c$) outweighs these costs.

92. In the case when $y=0$, the agent will not delegate stake. They can obtain better liquidity or a higher y_c via the native ether token, and would face *severe* adverse selection by delegating stake to an SSP running at a loss. The solo staker would presumably also not stake.

93. For those who want exposure to the ether token anyway, the decision may not hinge on if y_c is 1 % or 5 %. At 5 %, the ether token would presumably provide +5 %. Of course, that 5 % comes with risk attached and is not free money (neither should our yield be, hence MVI).

94. As y rises, prospective solo stakers and delegating stakers will gradually find the proposition to stake worth it, starting with the most ambitious/adventurous. We are here forming the supply schedule, where each agent makes a decision based on its unique circumstances.

95. It is not clear how the distribution of reservation yields varies between prospective solo stakers and delegating stakers. The proportion of solo stakers at a medium-run equilibrium of $d=0.2$ may be lower than at $d=0.6$, but the other option is also quite possible.

96. A higher d may allow for more diversity in SSPs, but the money-stratum for cartelization puts pressure in the other direction. The proportion of individuals holding enough ETH to solo stake is also limited, giving a soft upper bound on the total number of solo stakers.

97. This topic is certainly something that would be interesting to study further. The point is that opportunity costs of staking must always be fully accounted for, and that economies of scale and monopolization feed into the underlying equilibrium analysis in a rather complex way.

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98. Finally, restaking has the potential to put solo stakers on a more even footing. It enables them to "recollateralize" their stake if they so wish (however, if they want to provide economic security, they may encounter a principal—agent problem of their own).

99. A nice benefit of restaking is that if an active validator service (AVS) can quantify decentralization, it can also attach an economic surplus value to it. This is something that Ethereum as an open protocol is unable to do.

100. The previous arguments apply also to restaking on out-of-protocol EigenLayer features. At very low yields, users would be better off simply using non-staked ETH (free-staking). It seems reasonable for AVSs to prefer a token that cannot simply evaporate for many use cases.

101. Note also that if PEPC extends its scope beyond "block production use cases", the resulting yield may become somewhat more endogenous, depending on the surplus utility provided.

The road ahead

102. This concludes the discussion of the benefits and drawbacks of MVI. While there are causes for concern pertaining to solo staking, MVI is a fundamentally sound design policy that gives Ethereum a real shot at providing users with the best digital money ever created.

103. There are nuances to all arguments, and some deliberations cannot be conveyed succinctly in a Twitter thread. But I feel that when taking everything into consideration, it should be possible to accept MVI as an advantageous design principle also under PoS.

104. We must always focus on the "regular user" first and foremost, both by grounding the research in microfoundations, and by evaluating how we utility-maximize outcomes for regular people as Ethereum (hopefully) becomes their new financial system.

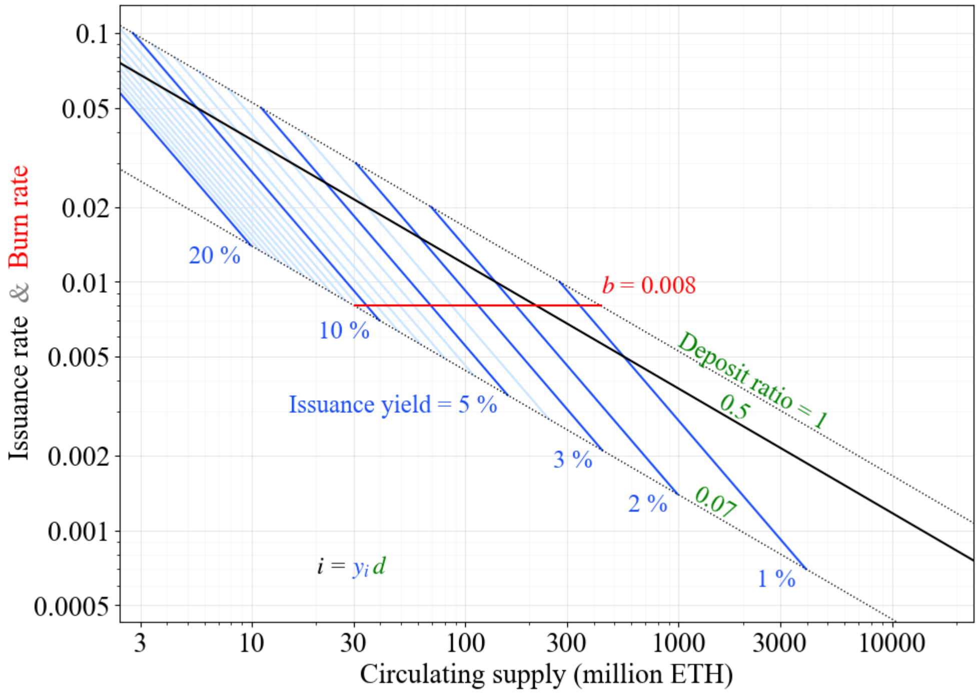
105. The issue then is how we achieve MVI, which is something I have been researching extensively. Dietrichs mentioned the importance of communicating current issuance-policy research in a recent developer call, and my process has begun with this thread.

106. Changing the issuance policy is a sensitive matter. What we aspire for is an issuance policy that maximizes utility, but where no further developer intervention is needed, such that it can keep portioning out a utility-maximizing MVI in all eternity.

107. However, the current reward curve does not let the protocol influence the deposit ratio (security), but rather the deposit size. In the medium run, outcomes are closely related, but the long-run equilibria may come to diverge significantly as the circulating supply drifts.

108. This was the topic of my 2021 Ethresearch post and talk at Devconnect: defining how the circulating supply S drifts to equilibrium ($i = b$) so that we can improve the reward curve and achieve minimum viable issuance under proof of stake.

109. Since the issuance rate can be expressed as $i = cF\sqrt{d}/\sqrt{S}$ under the current reward curve, it varies with the circulating supply (with some room for moderation through the deposit ratio). The figure shows Ethereum's issuance rate diagonal and the average b since The Merge.



110. The burn rate will not depend on the circulating supply---demand for blockspace is not changed by changing the denomination of the currency[If $i>b$, S will rise and bring down i until it equals b. If $i<b$, S will fall and bring up i until it equals b].

111. In a subsequent thread we will explore how the equilibrium relationship $b = y_id$, formed via $i = y_id$, impacts Ethereum's long-run security budget. Back in 2021, there was no REV for stakers, so I used reservation yield $\underline{y}$ directly, giving Ethereum's security as $d = b/\underline{y}$.

112. In the present day we may simply add the "REV rate" v to the equation $d = (b+v)/\underline{y}$. The point, which has been understood for two years now, is that we do not have long-run control over the deposit ratio and thus security, lest we are ready to intermittently alter F.

113. We can cut F as a temporary solution to not overpay for security (something we will discuss in the next thread). But eventually, Ethereum will return to the same long-run equilibrium deposit ratio (ceteris paribus), just under a lower circulating supply.

114. This is why we ultimately wish to change the reward curve to vary with d instead of D. It is then tempting to simply swap D for S_0d where S_0 is the present circulating supply. That takes us one step closer to an autonomous issuance policy but still does not guarantee it.

115. Assuming MEV burn, the protocol is then fully able to adapt to changes in income, but still cannot adapt to a permanent shift in reservation yields, i.e., the supply curve. This can instead be handled by allowing the entire reward curve (demand) to slowly drift.

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116. These topics, which we will explore over the next weeks, involve a closer look at discouragement attacks, the relevance of the slope of the reward curve, and the importance of time as a dimension in our analysis.

117. The endgame is a *dynamic equilibrium* where the circulating supply can change at a constant rate in the absence of external influence. Whether it inflates or deflates is determined by the supply curve and how blockspace value is reflected in the market cap of the ether token.

118. We thus achieve what [Polynya has referred to as "constant" security] which I think is a fitting description of our endgame, ultimately taking away control over issuance from developers and providing Ethereum with autonomy under MVI. See you soon!