# Liquid Staking and the Limits of Policy

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**ABSTRACT**

We study the role of liquid staking and how it affects the interaction between issuance policy, economic productivity, and security in proof-of-stake blockchains. In a dynamic macro-finance framework, we show that issuance redistributes resources from productive on-chain activity to validators, which effectively acts as a tax on productive capital. This mechanism generates a Laffer-curve-type tradeoff: beyond an interior optimum, higher issuance weakens the productive base that finances security and reduces staking rewards. We then introduce liquid staking, which allows users to earn staking rewards while retaining liquidity for productive use. Liquid staking collapses the traditional tradeoff between staking and DeFi. When liquid staking tokens (LSTs) closely substitute for the native asset and benefit from strategic complementarities, issuance reallocates productive activity toward LSTs, compresses the feasible policy space, and can render issuance and slashing ineffective as policy instruments.

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# I. Introduction

The defining feature of blockchain platforms is decentralized security: transactions are certified through a consensus of validators rather than by a central authority. Proof-of-stake platforms ensure security by requiring validators to lock ("stake") native tokens, which can be reduced ("slashed") if validators misbehave, and augmented with newly issued tokens if validators are honest. Besides staking, blockchains support a wide range of productive financial activities, collectively referred to as decentralized finance (DeFi). Because staking requires locking tokens that could otherwise be deployed in DeFi, platform policies manage a tradeoff: stronger staking incentives increase security, but at the cost of price dilution and reduced productive DeFi activity.

However, a new form of staking is beginning to reshape this tradeoff: liquid staking. Under this arrangement, users delegate staking to an intermediary, who passes the resulting issuance rewards through to the user, and issues a liquid token which can be used for DeFi. Liquid staking appears to solve a central inefficiency of proof-of-stake by eliminating the opportunity cost of staking. Our analysis shows, however, that by allowing users to stake without forgoing DeFi, liquid staking dissolves the traditional tradeoff at the heart of platform policy.

Our paper studies the consequences of this innovation through a macro-finance model that explicitly incorporates liquid staking. Our analysis yields three main results. First, higher issuance rewards no longer primarily harm DeFi productivity; instead, issuance harms decentralization by encouraging liquid staking through a central intermediary. Second, issuance leads more DeFi users to favor the liquid staking token (LST) over the native token. This effect is amplified when LSTs provide access to the same investment opportunities as the native token. Third, strategic complementarities arising from endogenous token liquidity can amplify this shift, replacing the native token in DeFi entirely and rendering issuance powerless to shape user incentives.

As a benchmark, we begin with a dynamic equilibrium model of a proof-of-stake blockchain without liquid staking. Users are endowed with dollar wealth, and they allocate that wealth dynamically between consumption, blockchain staking, and blockchain DeFi investment. Investment in DeFi generates productive stochastic returns, whereas staking earns platform rewards in the form of issued native tokens. In equilibrium, staking issuance has an indirect effect on user incentives because it dilutes the dollar value of DeFi tokens. This structure yields a tight link between productivity, issuance, and staking incentives: issuance directly shapes portfolio allocations, token prices, and the growth rate of aggregate on-chain wealth.

The baseline model yields the following results. Because issuance redistributes value rather than creating it, it acts as a distortionary tax on DeFi production. Thus, higher issuance raises staking rewards per unit of productive output but simultaneously discourages productive investment, shrinking the tax base that finances staking incentives. As a result, dollar staking revenues exhibit a Laffer-curve-type relationship with issuance. At low levels, higher issuance increases staking returns. Beyond an interior optimum, further issuance contracts the productive base so sharply that total staking revenues fall. In equilibrium, sufficiently aggressive issuance weakens the economic incentives that support security provision.

We then extend the model to incorporate liquid staking. Users can deploy both the native token and liquid staking tokens in DeFi, while liquid staking simultaneously earns issuance rewards. Issuance continues to tax productive use of the native token, but liquid staking tokens partially or fully avoid this tax. This asymmetry matters. Instead of mainly crowding out productive DeFi activity and pay for security, higher issuance pushes DeFi users away from native token and toward liquid staking tokens, which combine productivity with staking exposure.

The central implication is a breakdown of policy transmission. When liquid staking tokens are close substitutes for the native token for use on DeFi, equilibrium allocations can become largely insensitive to issuance, even to negative issuance. Defi activity migrates toward liquid staking tokens, which leaves most native tokens to be staked through the liquid staking intermediary. Issuance then loses its redistributive bite, even slashing can lose its deterrent force. Policy still affects token prices via dilution, but it no longer affects user behavior.

Whether this outcome arises depends on two economic forces. The first is correlation. When the productivity returns of LSTs closely track those of the native token, liquid staking replicates native token exposure while avoiding issuance taxation, which encourages widespread adoption. The second is strategic complementarity. As one type of token become more widely used as productive capital, its liquidity improves. Because issuance directly weakens returns to native tokens, it reduces their scale and raises usage costs, turning what is a first-order tax into a higher-order distortion once liquidity effects are anticipated. This feedback reinforces LST adoption and makes corner outcomes, such as near-universal liquid staking, more likely. When these forces are weak, issuance retains traction. When they are strong, issuance becomes powerless.

These results have direct implications for decentralization and security. High aggregate staking can coexist with reduced accountability, weakened incentives, and concentrated control over validation. Liquid staking intermediaries may come to dominate consensus even as measured staking levels rise. More broadly, the analysis highlights a limit of monetary policy in decentralized systems: when financial innovation allows users to evade policy-induced distortions, traditional incentive tools lose their force. Understanding this limit is central to the design of secure and genuinely decentralized blockchains.

## *A. Literature*

Our paper is part of a recent literature that uses dynamic models to study the effects of staking rewards. Cong, He, and Tang (2025) provide a foundational equilibrium framework for understanding how staking rewards affect platform productivity and token price. Jermann (2023) uses a dynamic equilibrium macro model to study how issuance, fees, and Layer 2 (L2) activity affect the money supply and price dynamics, and Jermann (2024) characterizes the optimal issuance policy. A central ingredient of these models is the natural assumption, motivated by the historical realities of proof-of-stake platforms, that users must choose between staking and DeFi.

Our paper builds on these dynamic frameworks by incorporating the increasingly popular choice to liquid stake. We show that liquid staking dissolves the classic staking-DeFi tradeoff, reducing issuance policy's ability to influence equilibrium outcomes, and centralizing power in the liquid staking intermediary.

A recent note, Jermann (2025), extends the model of Jermann (2024) to include intermediated staking. In this setup, stakers can choose between solo staking and using an intermediary, which entails lower fixed costs but higher variable costs than solo staking. By contrast, our paper focuses on a specific and transformative form of intermediation: liquid staking. In our model, liquid staking dominates solo staking because it offers not only staking rewards but also a liquid token which can be used on DeFi.

In recent work, Harvey, John, and Saleh (2025) study settlement security in proof-of-stake blockchains, showing how higher productive value from blockchain execution increases staking investment, reduces circulating supply, and raises the cost of attacks through endogenous price impact. Like our paper, their framework recognizes that staking rewards are ultimately financed by users and that issuance functions as a transfer from productive activity to security provision, creating a tension between productivity and staking incentives. Our contribution builds on this insight by making this tension explicit as a Laffer-curve–type tradeoff: beyond a point, higher issuance weakens the productive base that finances security. We then show how the introduction of liquid staking alters this tradeoff by allowing staking rewards to be earned without a corresponding reduction in productive liquidity, changing the transmission of issuance and slashing and weakening the link between productivity and security.

A related body of work emphasizes security and incentive provision in proof-of-stake systems. Saleh (2021) provides a foundational economic analysis of proof-of-stake consensus, highlighting how staking incentives replace the resource expenditure of proof-of-work. Subsequent work with coauthors, including John, Rivera, and Saleh (2025), studies equilibrium staking levels under heterogeneous horizons and block reward policies, clarifying how security depends on both participation and incentive design. Together, these papers establish the economic logic of staking as a mechanism for decentralized security.

A growing recent literature studies liquid staking and liquid staking derivatives as financial instruments and institutional arrangements within proof-of-stake blockchains. Theoretical literature examines liquid staking in general equilibrium, emphasizing conditions under which liquid staking improves capital efficiency or, conversely, weakens security incentives (e.g., Carré and Gabriel (2024)). Several papers analyze the pricing, liquidity, and market behavior of liquid staking tokens, documenting deviations from parity with the underlying staked asset, the role of arbitrage frictions, and the contribution of liquid staking derivatives to price discovery and on-chain liquidity (e.g., Scharnowski and Jahanshahloo (2025); Xiong, Wang, and Wang (2024); Kraner, Pennella, Vallarano, and Tessone (2025)). Complementary work studies leveraged positions and rehypothecation chains built on liquid staking tokens, highlighting their intensive reuse in DeFi and the potential amplification of shocks (e.g., Xiong, Wang, Chen, Knottenbelt, and Huth (2025)). Finally, systematization and survey work documents the institutional design of liquid staking and related innovations such as restaking, clarifying protocol mechanics, risk channels, and emerging market structures (e.g.,Gogol, Velner, Kraner, and Tessone (2024)). Relative to this literature, our contribution is to embed liquid staking directly into a macro-style model of proof-of-stake policy, showing how liquid staking alters the transmission of issuance and slashing by relaxing the traditional tradeoff between staking and productive activity, and thereby reshapes the effectiveness of protocol-level security incentives.

Section II presents the baseline model, characterizes the equilibrium allocation of security and productivity, and demonstrates monetary non-neutrality of the issuance policy. Section III extends the model to incorporate liquid staking and shows how it can lead to monetary neutrality of the issuance policy, especially when strategic complementarities accelerate LST dominance on DeFi. Section IV concludes.

# II. Productivity, issuance, and security

In a blockchain economy without liquid staking, the distribution of wealth between (i) productive users who generate value through financial activity and (ii) users who provide security through staking is central. In our model, issuance acts as a policy instrument that redistributes wealth from productive activity to security providers, effectively taxing DeFi productivity to finance consensus participants. Productivity generates dollar returns that expand the economic base of the blockchain, while issuance determines how these returns are shared between productive users and stakers. Through this channel, issuance shapes user portfolio incentives, the allocation of native tokens between productive use and staking, and ultimately the joint determination of blockchain productivity and security.

In our baseline model, the blockchain ecosystem is a small open economy embedded within the broader dollar economy. Section II.A presents the general features of the baseline model, Section II.B frames the problem of a blockchain user as a portfolio problem, Section II.C describes DeFi and staking market clearing conditions, Section II.D describes the equilibrium token prices and allocations to productivity and consensus under a given issuance policy, and discusses blockchain monetary non-neutrality.

## *A. General features*

There is a continuum of homogeneous users with unit mass, and time is continuous. The dollar economy features a representative consumption good, whose price is constant and normalized to one. Each user $i \in [0,1]$ in the blockchain economy chooses a lifetime consumption stream $\{c_t^i\}_{t=0}^{\infty}$ to maximize

$$\mathbb{E}_0 \left[ \int_0^{\infty} e^{-\beta t} \log(c_t^i) \, dt \right], \tag{1}$$

where $\beta > 0$ is the discount, or impatience, parameter. Importantly, agents consume dollars rather than native tokens.

Each user is endowed with initial wealth $x_0$ in dollars. At each time $t \geq 0$, users allocate their wealth between consumption and two blockchain investments: DeFi and staking. Both investments require users to lock wealth on the blockchain and hold the native token.

When assessing the profitability of each option, each infinitesimal blockchain user $i$ takes as given the dynamics of dollar prices $P_t$ of the native token, the supply $Q_t$ of the native token, the issuance policy $I_t$ of the blockchain, and the relevant aggregate states of the economy. Specifically, users take as given the dollar value of productive tokens, $D_t$, and of staked tokens, $S_t$. As described below, individual blockchain participants take prices as given, while as a group they affect them. Below, we describe the components of dollar returns associated with each investment.

**Productivity and returns to DeFi.** The blockchain economy offers financial and monetary services that generate real economic value in dollar terms. Productivity arises from attracting inflows through user adoption or from the creation of new services and technologies that increase the blockchain's fundamental value.

We assume that blockchain productivity is proportional to the dollar value of wealth locked and circulating within the blockchain's DeFi protocols. Hereafter, we refer to the value generated by the blockchain through these channels as *DeFi productivity*.

The return to one dollar due to DeFi productivity is stochastic and follows the process

$$\mu_D \, dt + \sigma_D \, dW_{D,t} \,, \tag{2}$$

where $\mu_D > 0$ is a known deterministic drift capturing the expected growth of the blockchain economy due to wealth locked in DeFi protocols, $W_{D,t}$ is a Brownian motion representing productivity shocks, and $\sigma_D$ scales the magnitude of these shocks. Shocks include exogenous demand shocks as well as shocks to the fundamental value of the blockchain, including hacks and political risk.

By holding the native token in DeFi protocols, users are exposed to token price fluctuations. In our framework, the price of the native token reflects demand for access to blockchain services, both for DeFi activity and for consensus participation. We assume that the native token price inherits DeFi risk and follows

$$\frac{dP_t}{P_t} = \mu_{P,t} \, dt + \sigma_{P,t} \, dW_{D,t} \,. \tag{3}$$

The drift $\mu_{P,t}$ and volatility $\sigma_{P,t}$ are determined endogenously. Issuance is not introduced as an explicit tax in DeFi returns. Instead, issuance affects incentives through equilibrium token price dynamics. Changes in token prices and token holdings of DeFi users and consensus participants constitute the channel through which issuance operates as a tax on productive activity.

Combining stochastic productivity with token price dynamics yields the dollar return to DeFi,

$$\frac{d\nu_{D,t}}{\nu_{D,t}} = \mu_D \, dt + \sigma_D \, dW_{D,t} + \frac{dP_t}{P_t} \,. \tag{4}$$

**Issuance and staking returns.** We assume that issuance takes the form of a proportional rate, denoted by $dI_t/I_t$, applied to the number of staked tokens. Accordingly, the number of tokens issued at time $t$ is

$$\underbrace{\frac{S_t}{P_t}}_{\text{number of staked tokens}} \times \underbrace{\frac{dI_t}{I_t}}_{\text{issuance policy}} . \tag{5}$$

The blockchain protocol chooses and publicly commits to an issuance rule $dI_t/I_t$ that determines the flow of newly issued tokens and we write[1]

$$\frac{dI_t}{I_t} = \mu_{I,t}\, dt\,, \tag{6}$$

where $\mu_{I,t}$ governs the baseline issuance stance of the protocol.

Issuance $I_t$ is interpreted here as an *average* issuance rate received by each staker. We do not explicitly model the mechanism that selects individual consensus participants and the resulting idiosyncratic realization of validation rewards at a given point in time. The model can be extended to incorporate idiosyncratic issuance risk at the user level and canceling out in the aggregate, as in continuous-time macro-finance models; see, for example, Brunnermeier and Sannikov (2014).

The dollar value of wealth distributed to stakers is due to changes in token holdings becaus eof newly issued tokens given to stakers, but also due to price changes. The return to staking, per dollar locked in staking, is therefore

$$\frac{d\nu_{S,t}}{\nu_{S,t}} = \underbrace{\frac{dI_t}{I_t}}_{\text{tokens distributed to stakers}} + \underbrace{\frac{dP_t}{P_t}}_{\text{token price changes}} . \tag{7}$$

## B. *Blockchain user portfolio problem*

Let $x_t^i$ denote the dollar net worth of user $i \in [0,1]$ at time $t$. Each user allocates a fraction $\theta_t^i$ of wealth to DeFi protocols, with the remaining share $1-\theta_t^i$ invested in staking. We rule out borrowing and short selling and restrict $\theta_t^i$ to lie in $[0,1]$.

Users take as given the dollar value of productive tokens $D_t$, staked tokens $S_t$, and the blockchain's issuance policy. Given these objects, individual wealth evolves according to

$$\frac{dx_t^i}{x_t^i} = \theta_t^i \frac{d\nu_{D,t}}{\nu_{D,t}} + \left(1-\theta_t^i\right) \frac{d\nu_{S,t}}{\nu_{S,t}} - \frac{c_t^i}{x_t^i}\, dt, \tag{8}$$

where asset returns are in (7) and (4).

Users have logarithmic preferences over consumption. The next result characterizes op-

[1] A more general specification of issuance policy as one which reacts to productivity shocks is also possible here.

timal consumption and portfolio choice.

PROPOSITION 1: *Fix user $i \in [0,1]$. Optimal consumption satisfies*

$$c_t^{i\star} = \beta\, x_t^i.$$

*The optimal share of wealth invested in DeFi protocols is identical across users. It satisfies $\theta_t^{i\star} = 0$ if $\mu_{I,t} \geq \mu_D - \sigma_D\sigma_{P,t}$ and $\theta_t^{i\star} = 1$ if $\mu_{I,t} \leq \mu_D - \sigma_D^2 - \sigma_D\sigma_{P,t}$. Otherwise, the optimal portfolio share is given by*

$$\theta_t^{i\star} = \theta_t^\star = \frac{\mu_D - \mu_{I,t} - \sigma_D\sigma_{P,t}}{\sigma_D^2}\,. \tag{9}$$

Proposition 1 shows that, for given token price volatility loading $\sigma_{P,t}$, the individual share of productive tokens is decreasing in the issuance tax. The result further identifies an upper threshold $\mu_D - \sigma_D\sigma_{P,t}$ of issuance beyond which all users optimally stake, and a lower threshold $\mu_D - \sigma_D^2 - \sigma_D\sigma_{P,t}$ below which all users optimally allocate their wealth to productive activity. These are further discussed below when we derive equilibrium allocations and token prices.

## C. Clearing conditions

Aggregate user wealth equals the market capitalization of native tokens and satisfies

$$x_t = \int_0^1 x_t^i\, di = P_t Q_t. \tag{10}$$

Portfolio choices clear the DeFi and staking markets,

$$D_t = \theta_t x_t \qquad \text{and} \qquad S_t = (1-\theta_t)x_t. \tag{11}$$

Therefore, the total dollar value of productive and staked native tokens equals market capitalization,

$$D_t + S_t = P_t Q_t. \tag{12}$$

**Token supply.** The aggregate supply $Q_t$ of the native token evolves through issuance applied to staked tokens. Since issuance is levied at rate $dI_t/I_t$ on the quantity of staked tokens $S_t/P_t$, token supply satisfies

$$dQ_t = \frac{S_t}{P_t}\frac{dI_t}{I_t}. \tag{13}$$

Using the market clearing condition in (11), the law of motion for token supply can be written as

$$\frac{dQ_t}{Q_t} = \frac{S_t}{P_t Q_t}\,\frac{dI_t}{I_t} = (1-\theta_t^\star)\,\mu_{I,t}\,dt, \tag{14}$$

where $\theta_t^\star$ is defined in (9).

**Market capitalization of the native token.** In this baseline model, issuance redistributes wealth from productive users to stakers and therefore cancels out in the aggregate. Issuance neither creates nor destroys dollars in the blockchain economy. As a result, the instantaneous change in the native token market capitalization $P_t Q_t$ is driven solely by productive returns and consumption,

$$d(P_t Q_t) = D_t\,(\mu_D\,dt + \sigma_D\,dW_{D,t}) - \left(\int_0^1 c_t^{i\star}\,di\right) dt. \tag{15}$$

Using the DeFi market clearing condition (11), the optimal consumption rule in Proposition 1, and the aggregate wealth identity (10), the law of motion for native token market capitalization can be written as

$$\frac{d(P_t Q_t)}{P_t Q_t} = \theta_t^\star\,(\mu_D\,dt + \sigma_D\,dW_{D,t}) - \beta\,dt. \tag{16}$$

Although issuance operates as a transfer at each instant, it affects equilibrium market capitalization dynamics through its impact on the endogenous allocation $\theta_t^\star$ between productive activity and consensus. By distorting portfolio choice, issuance shapes the growth rate of aggregate on-chain wealth over time.

## *D. Equilibrium*

This section studies the equilibrium properties of proof-of-stake blockchains without liquid staking. Given exogenous productivity shocks, issuance policy, and initial conditions for $\{P_t, Q_t, D_t, S_t\}$, a competitive equilibrium consists of portfolio allocations $(\theta_t^i)_{t\geq 0}$, consumption plans $(c_t^i)_{t\geq 0}$, prices $(P_t)_{t\geq 0}$, and token supply $(Q_t)_{t\geq 0}$, such that all users maximize utility and markets clear.

The following proposition characterizes the symmetric equilibrium. It derives equilibrium token price dynamics and the allocation of wealth between DeFi and consensus.

PROPOSITION 2: *In equilibrium, token prices follow the dynamics in* (3) *with loadings*

$$\mu_{P,t} = -(1-\theta_t^\star)\,\mu_{I,t} + \theta_t^\star\,\mu_D - \beta, \qquad \sigma_{P,t} = \theta_t^\star\,\sigma_D. \tag{17}$$

*The equilibrium portfolio allocation is identical across users. It satisfies*

$$\theta_t^\star = 0 \quad \textit{if} \quad \mu_{I,t} \geq \mu_D,$$

*and*

$$\theta_t^\star = 1 \quad \textit{if} \quad \mu_{I,t} \leq \mu_D - 2\sigma_D^2.$$

*Otherwise, the equilibrium allocation is given by*

$$\theta_t^\star = \frac{\mu_D - \mu_{I,t}}{2\sigma_D^2}. \tag{18}$$

**Equilibrium allocation.** The equilibrium allocation in (18) is jointly determined by expected productivity, risk, and issuance. A mixed allocation between consensus and productive activity is feasible only when the issuance rate lies in the interval

$$\mu_{I,t} \in [\mu_D - 2\sigma_D^2, \mu_D].$$

The upper threshold $\mu_D$ represents the maximal issuance rate compatible with a positive allocation to DeFi in equilibrium. When issuance exceeds this level, staking strictly dominates DeFi, all users optimally allocate their wealth to consensus, and productive activity vanishes. As shown below, in this regime the equilibrium return to staking converges to zero and the blockchain effectively shuts down.

The lower threshold $\mu_D - 2\sigma_D^2$ is the issuance rate below which full adoption of DeFi is optimal in equilibrium. This threshold reflects the fact that when issuance is sufficiently low, staking is dominated even as a marginal hedge. In this case, at full DeFi adoption, any infinitesimal reallocation toward staking reduces welfare.

For issuance rates in the interior of this interval, the equilibrium share of productive tokens is strictly decreasing in issuance. As issuance rises, users reduce exposure to DeFi in order to avoid dilution. As issuance approaches its upper bound $\mu_D$, the equilibrium allocation converges to zero, and the issuance discount reaches its maximal magnitude $\mu_D/(2\sigma_D^2)$.

The corner cases described above should not be interpreted literally. In practice, there exists a minimum level of security, or equivalently, a lower bound on $S_t$, below which the blockchain becomes insecure. Users investing in the blockchain anticipate this constraint, and as a result productive activity may cease in equilibrium before the optimal allocation to DeFi reaches $\theta_t^\star = 1$. Similarly, there exists a minimum level of productivity below which staking returns effectively approach zero, prompting users to reallocate wealth to an outside investment option before $\theta_t^\star$ reaches zero. Thus, the blockchain would fail before either extreme allocation is attained. A straightforward extension of the model would impose endogenous bounds on equilibrium allocations, yielding $\theta_t^\star \in [\underline{\theta}, \overline{\theta}]$, where $\underline{\theta} > 0$ reflects the minimum productivity required to sustain economic activity and $\overline{\theta} < 1$ reflects the minimum staking required to ensure economic security $(1-\overline{\theta})P_tQ_t$.

**Token prices.** Expected token price growth $\mu_{P,t}$ in (17) is composed of two components. The first component is the discounted value of productive blockchain activity, $\theta_t^\star \mu_D - \beta$. DeFi productivity $\mu_D$ is scaled by the endogenous share $\theta_t^\star$ of dollar wealth allocated to productive tokens. This share is decreasing in the issuance rate as shown in (18). Issuance therefore affects native token prices by distorting portfolio choices and reducing the fraction of tokens employed in productive activity.

The second component of expected token price growth is the inflationary effect of issuance. This effect dilutes native token prices and is captured by the term $-(1-\theta_t^\star)\mu_{I,t}$, which scales with the share of wealth allocated to staking.

Token price volatility in (17) reflects productivity risk scaled by the equilibrium share of productive native tokens.

We show next that portfolio choice effects on productivity and token prices jointly imply that issuance operates as a tax on productive tokens.

**Issuance as a tax.** Blockchains rely on productive activity to finance security. Issuance redistributes wealth from DeFi users toward stakers, which makes staking profitable in dollar terms rather than only in native token units. Thus, in blockchains, dollar staking returns are jointly determined by issuance and productivity.

To illustrate this mechanism, combine the returns to staking in (7), the returns to DeFi in (4), and the equilibrium characterized in Proposition 2, to write the equilibrium return, relative to native token market capitalization $P_tQ_t$, distributed to productive users as

$$\frac{D_t}{P_t\,Q_t}\,\frac{d\nu_{D,t}}{\nu_{D,t}} = \theta_t^\star\left((\mu_{P,t}+\mu_D)\,dt + (\sigma_{P,t}+\sigma_D)\,dW_{D,t}\right) \tag{19}$$

$$= \underbrace{\frac{\mu_D-\mu_{I,t}}{2\sigma_D^2}}_{\text{DeFi share}}\;\underbrace{\left(\left(\frac{\mu_D^2-\mu_{I,t}^2}{2\sigma_D^2}-\beta-\mu_{I,t}+\mu_D\right)dt + \left(\frac{\mu_D-\mu_{I,t}}{2\sigma_D}+\sigma_D\right)dW_{D,t}\right)}_{\text{discounted productivity}}, \tag{20}$$

and the equilibrium return distributed to stakers as

$$\frac{S_t}{P_t Q_t} \frac{d\nu_{S,t}}{\nu_{S,t}} = (1-\theta_t^\star)\left((\mu_{I,t}+\mu_{P,t})\,dt + \sigma_{P,t}\,dW_{D,t}\right) \tag{21}$$

$$= \underbrace{\left(1 - \frac{\mu_D - \mu_{I,t}}{2\sigma_D^2}\right)}_{\text{staking share}} \underbrace{\left(\frac{\mu_D^2 - \mu_{I,t}^2}{2\sigma_D^2}\,dt - \beta\,dt + \frac{\mu_D - \mu_{I,t}}{2\sigma_D}\,dW_{D,t}\right)}_{\text{issuance and discounted productivity}}. \tag{22}$$

The expected dollar profitability of DeFi is composed of two components. The first component is the portfolio share $\theta_t^\star$ allocated to DeFi, which decreases with issuance because users avoid the issuance tax. The second component is discounted blockchain profitability, which also declines as issuance rises due to the redistribution of wealth toward stakers. Issuance therefore deters DeFi through two channels. It transfers wealth from productive users to stakers, and it reduces the equilibrium allocation to productive tokens.

The expected dollar profitability of staking is also composed of two components. The first component is the staking share $1-\theta_t^\star$, which increases with issuance as staking becomes relatively more attractive. The second component consists of discounted blockchain productivity and issuance revenue. These returns originate from productive activity and decline with issuance through the feedback effect of a lower equilibrium allocation to DeFi and lower dollar wealth produced on the blockchain.

As a result, staking profitability is increasing at low issuance rates and decreasing at high issuance rates, with an interior maximum. A higher issuance rate raises the effective tax on productive output but simultaneously contracts the productive base. Beyond a threshold, the reduction in the tax base dominates the increase in the tax rate, causing total issuance revenue and dollar staking returns to decline.

This result can be interpreted as a Laffer curve. Issuance acts as a distortionary tax on productive blockchain activity: low issuance fails to generate sufficient staking rewards, while excessive issuance discourages production and erodes the tax base. As a consequence, staking revenues are maximized at an interior level of issuance. This mechanism is illustrated in Figure 1.

Another risk of issuance is that it can hinder blockchain adoption. A natural extension of the model allows users to allocate wealth to an outside investment opportunity, such as a risk-free dollar asset. In this case, as issuance increases and productive activity contracts, the resulting rise in the staking share reduces equilibrium staking returns, which eventually converge to zero. Once staking returns fall below the outside option, users optimally withdraw capital from the blockchain altogether. This mechanism implies that sufficiently aggressive issuance policies can reduce on-chain participation and, ultimately, blockchain adoption.

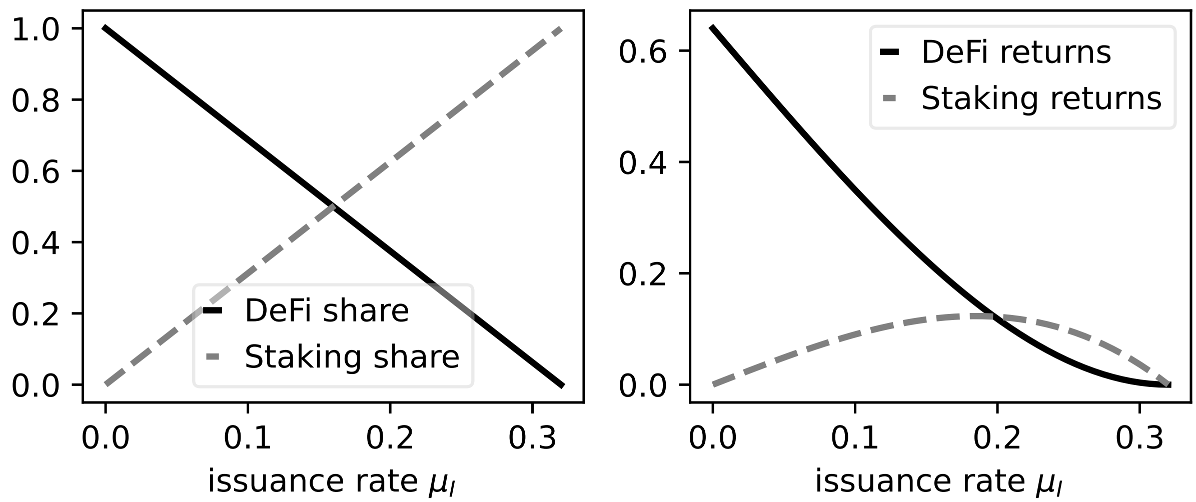


**Figure 1.** Left panel: equilibrium portfolio share allocated to productive tokens and to staking as function of the issuance rate $\mu_I$. Right panel: returns to DeFi and staking as functions of the issuance rate $\mu_I$. Model parameters are $\sigma_D = 0.4$, $\mu_D = 0.32$, and $\beta = 0.01$.

**Policy and monetary non-neutrality.** In our baseline model, issuance policy directly affects users' incentives to engage in productive activity or to participate in consensus, and thereby influences native token prices, reflecting monetary non-neutrality. Issuance can thus be used as a policy instrument to shape the allocation of native tokens between productive uses and staking, allowing the protocol to jointly determine equilibrium blockchain productivity and economic security for a given policy objective.

More broadly, our analysis shows that although issuance affects user incentives, achieving economic security through issuance alone is more difficult than commonly assumed. Security policies that rely exclusively on higher issuance may therefore become self-defeating beyond a certain point. In particular, long-run economic security may require an initial phase in which productivity is incentivized and security is temporarily relaxed in order to expand the tax base from which staking rewards are drawn, followed by a phase in which issuance targets a given dollar value of staking.

As we show below, when blockchain economies allow liquid staking tokens to be used for productive activity, an equilibrium may emerge in which users optimally rely exclusively on LSTs to generate value on the blockchain. In this scenario, issuance becomes ineffective as a policy instrument, since it no longer influences user incentives or portfolio choices. In Section III, we show that issuance, the expanding use of LSTs that replicate native-token investment opportunities, and additional forces arising from strategic complementarities jointly push the economy toward this equilibrium.

Designing optimal issuance policies is beyond the scope of this paper. We refer the reader to Cong, Li, and Wang (2021); Jermann (2023); Jermann and Xiang (2025) for complementary approaches to optimal policy design in tokenized economies.

# III. Liquid staking and the limits of policy

Liquid staking allows proof-of-stake users to delegate consensus work to specialized operators while receiving a derivative token that represents their staked position. Unlike solo staking, which requires dedicated hardware, technical expertise, and a significant minimum stake, liquid staking lowers participation costs and abstracts away operational complexity. The resulting liquid staking tokens (LSTs) are fully transferable and can be used in DeFi. This feature makes staked capital productive while still earning staking rewards. As a result, liquid staking has become one of the dominant forms of staking, and it accounts for a large and growing share of both total staked tokens and on-chain economic activity.

In a blockchain economy with liquid staking, users can be productive using both the native token and LSTs. The distribution of wealth between (i) productive users who generate value with native tokens, (ii) productive users who provide security while generating value with LSTs, and (iii) users who only provide security through staking (pure staking) becomes central.[2]

Section III.A presents the general features of the baseline model. Section III.B formulates the blockchain user problem as a portfolio choice. Sections III.C and III.D characterize equilibrium token prices and the allocation between DeFi and staking under a given issuance policy. Section III.E shows how issuance and the adoption of LSTs shift the blockchain economy toward an equilibrium in which LSTs become the sole vehicle for productive activity and issuance policy loses effectiveness. Section III.F shows how strategic complementarities amplify and accelerate this shift.

## *A. General features*

As in Section II, a continuum of homogeneous blockchain users chooses a lifetime consumption stream $\{c_t^i\}_{t=0}^{\infty}$ to maximize logarithmic utility over dollar consumption. At each time $t \geq 0$, users allocate wealth between consumption and three blockchain investments: DeFi with native tokens, DeFi with LSTs, and staking. We next describe the return structure associated with each investment.

[2]Our model does not differentiate between staker types. Staking can occur either through passive (not used on DeFi) holding of LSTs or through solo staking. Analyzing the composition and diversity of the staking pool is beyond the scope of this paper.

As in the baseline model, issuance is paid proportionally to staked capital. At time $t$, the total dollar value of issuance distributed to stakers and liquid stakers is $(S_t + L_t)\, dI_t/I_t$. This amount is redistributed away from productive native token holders.

**Returns to DeFi with native tokens.** As in Section II.A, DeFi activity conducted with native tokens generates stochastic productivity and exposes users to changes in the native token price. Combining these components, the return to DeFi with native tokens is

$$\frac{d\nu_{D,t}}{\nu_{D,t}} = \mu_D\, dt + \sigma_D\, dW_{D,t} + \frac{dP_t}{P_t}\,. \tag{23}$$

**Returns to DeFi with LSTs.** We next consider DeFi activity conducted with LSTs. Unlike native tokens, LST based DeFi positions generate both stochastic productivity and issuance revenue, since LST holders are effectively staking. The return to DeFi with LSTs is given by

$$\frac{d\nu_{L,t}}{\nu_{L,t}} = \underbrace{\mu_L\, dt + \xi_L\, dW_{L,t}}_{\text{stochastic productivity}} + \underbrace{\mu_{I,t}\, dt}_{\text{issuance}} + \underbrace{\frac{dP_t}{P_t}}_{\text{token price changes}}, \tag{24}$$

where $\mu_L$ denotes the expected productivity of LST based DeFi activity and $\xi_L$ its volatility.

Productivity shocks to DeFi with native tokens and with LSTs may be correlated,

$$\langle W_D, W_L \rangle_t = \rho\, t, \qquad \rho > 0,$$

where $\rho$ measures the extent to which LSTs provide access to the same investment opportunities as native tokens in DeFi. A higher correlation corresponds to LSTs being closer substitutes for the native token in DeFi, while a lower correlation reflects frictions or limitations in LST usability.

**Returns to staking.** The return to staking, whether through solo staking or passive holding of LSTs, is

$$\frac{d\nu_{S,t}}{\nu_{S,t}} = \mu_{I,t}\, dt + \frac{dP_t}{P_t}\,. \tag{25}$$

## *B. Blockchain user portfolio problem*

The price of the native token reflects demand for access to blockchain services, whether for DeFi with native tokens, DeFi with LSTs, or pure staking. Token price dynamics inherit productivity shocks from both sources and satisfy

$$\frac{dP_t}{P_t} = \mu_{P,t}\, dt + \sigma_{P,t}\, dW_{D,t} + \xi_{P,t}\, dW_{L,t}\,, \tag{26}$$

where the loadings $\mu_{P,t}$, $\sigma_{P,t}$, and $\xi_{P,t}$ are determined in equilibrium.

Let $x_t^i$ denote the dollar net worth of user $i \in [0,1]$ at time $t$. Each user allocates a fraction $\theta_t^i$ of wealth to DeFi using the native blockchain token, a fraction $\varphi_t^i$ to DeFi using LSTs, and the remaining share $1-\theta_t^i-\varphi_t^i$ to pure staking. We rule out borrowing and short selling and restrict allocations to lie in $[0,1]$.

Users take as given the blockchain's issuance policy. Individual wealth evolves according to

$$\frac{dx_t^i}{x_t^i} = \theta_t^i\,\frac{d\nu_{D,t}}{\nu_{D,t}} + \varphi_t^i\,\frac{d\nu_{L,t}}{\nu_{L,t}} + \left(1-\theta_t^i-\varphi_t^i\right)\frac{d\nu_{S,t}}{\nu_{S,t}} - \frac{c_t^i}{x_t^i}\,dt, \tag{27}$$

where asset returns are in (23), (24), and (25). All users choose identical portfolio allocations, so we drop the index $i$. The next result characterizes optimal consumption and portfolio choice.

PROPOSITION 3: *Fix a user $i \in [0,1]$. Optimal consumption satisfies $c_t^{i\star} = \beta x_t^i$. If the interior allocation*

$$\theta_t^\star = \frac{1}{(1-\rho^2)\sigma_D^2}\Big(\mu_D - \mu_{I,t} - \rho\,\frac{\sigma_D}{\xi_L}\mu_L\Big) - \frac{\sigma_{P,t}}{\sigma_D}, \qquad \varphi_t^\star = \frac{1}{(1-\rho^2)\xi_L^2}\Big(\mu_L - \rho\,\frac{\xi_L}{\sigma_D}(\mu_D - \mu_{I,t})\Big) - \frac{\xi_{P,t}}{\xi_L} \tag{28}$$

*lies in the feasible set $\{(\theta,\varphi):\ 0\le\theta,\ 0\le\varphi,\ \theta+\varphi\le 1\}$, then it is the unique optimal portfolio choice. If the interior solution is not feasible, the optimal allocation is the maximizer among the following corner cases.*

1. *DeFi with LSTs only: $\theta_t^\star = 0$ and*

$$\varphi_t^\star = \min\Big\{\max\Big\{\frac{\mu_L - \xi_L(\xi_{P,t} + \rho\sigma_{P,t})}{\xi_L^2}, 0\Big\}, 1\Big\}. \tag{29}$$

2. *DeFi with native tokens only: $\varphi_t^\star = 0$ and*

$$\theta_t^\star = \min\Big\{\max\Big\{\frac{\mu_D - \mu_{I,t} - \sigma_D\sigma_{P,t}}{\sigma_D^2}, 0\Big\}, 1\Big\}.$$

3. *No staking: $\theta_t^\star + \varphi_t^\star = 1$ and*

$$\theta_t^\star = \frac{\mu_D - \mu_L - \mu_{I,t} - \big((\sigma_D - \rho\xi_L)\sigma_{P,t} + (\rho\sigma_D - \xi_L)(\xi_{P,t} + \xi_L)\big)}{\sigma_D^2 + \xi_L^2 - 2\rho\sigma_D\xi_L}. \tag{30}$$

In the interior solution (28), portfolio allocations respond to risk adjusted productivity. An increase in the expected productivity of DeFi with native tokens raises the optimal allocation to productive native tokens. An increase in the expected productivity of DeFi with LSTs raises the allocation to productive LSTs.

Issuance enters the portfolio problem asymmetrically. Since issuance dilutes only non staked tokens, it acts as a tax on productive native token holders who do not stake. An increase in the issuance rate therefore reduces the allocation $\theta_t^\star$ to productive native tokens and increases the relative attractiveness of productive LSTs and pure staking. Higher issuance reallocates wealth away from productive native tokens and toward productive LSTs and staking rather than crowding out all DeFi activity as in Section II.

Next, we describe the role of correlation $\rho$ between the productivity of native tokens and that of LSTs. When correlation is low and tends to zero, the optimal allocations become

$$\theta_t^\star = \frac{\mu_D - \mu_{I,t}}{\sigma_D^2} - \frac{\sigma_{P_t}}{\sigma_D} \quad \text{and} \quad \varphi_t^\star = \frac{\mu_L}{\xi_L^2} - \frac{\xi_{P_t}}{\xi_L}\,.$$

In this case, issuance reallocates wealth away from native-token DeFi toward pure staking rather than toward LSTs, since the excess return of LSTs over staking is driven solely by productivity. Positive correlation reintroduces an indirect effect of issuance on $\varphi$ through diversification motives. Issuance-induced reductions in productive native tokens affect the optimal diversification allocation to LST-based DeFi. In this case, issuance reallocates wealth away from native-token DeFi toward both productive LSTs and pure staking.

## C. *Clearing conditions*

Let $D_t$ denote the dollar value of productive native tokens, $L_t$ the dollar value of productive LSTs, and $S_t$ the dollar value of staked tokens. As in Section III.C, aggregate user wealth equals the market capitalization of the native token,

$$x_t = \int_0^1 x_t^i \, di = P_t Q_t. \tag{31}$$

Portfolio choices clear the markets for productive native tokens, productive LSTs, and staking,

$$D_t = \theta_t x_t, \qquad L_t = \varphi_t x_t, \qquad S_t = (1 - \theta_t - \varphi_t) x_t. \tag{32}$$

The total dollar value of productive and staked tokens equals the market capitalization of native tokens,

$$D_t + L_t + S_t = P_t Q_t. \tag{33}$$

**Token supply.** The supply $Q_t$ of native tokens evolves through issuance distributed to LST holders and pure stakers. Issuance applies at rate $dI_t/I_t$ to the quantity $(L_t + S_t)/P_t$ of staked tokens, so that

$$dQ_t = \frac{L_t + S_t}{P_t}\frac{dI_t}{I_t}. \tag{34}$$

Use the issuance form (6) and the clearing conditions (31) and (32) to write the equilibrium dynamics of native token supply as

$$dQ_t = \frac{S_t + L_t}{P_t}\frac{dI_t}{I_t} = (1 - \theta_t^\star)\, Q_t\, \mu_{I,t}\, dt\,. \tag{35}$$

**Market capitalization of the native token.** In the presence of LSTs, issuance redistributes wealth from productive users that employ native tokens toward stakers and toward productive users that employ LSTs. This redistribution washes out in the aggregate and neither creates nor destroys dollars in the blockchain economy. As a result, the instantaneous change in native token market capitalization $P_tQ_t$ is driven by productive returns and consumption only,

$$d(P_tQ_t) = D_t\big(\mu_D\, dt + \sigma_D\, dW_{D,t}\big) + L_t\big(\mu_L\, dt + \xi_L\, dW_{L,t}\big) - \left(\int_0^1 c_t^{i\star}\, di\right) dt. \tag{36}$$

Using the market clearing conditions in (32), the aggregate wealth identity in (31), and the optimal consumption rule in Proposition 3, the law of motion for native token market capitalization can be written as

$$\frac{d(P_tQ_t)}{P_tQ_t} = \theta_t^\star\big(\mu_D\, dt + \sigma_D\, dW_{D,t}\big) + \varphi_t^\star\big(\mu_L\, dt + \xi_L\, dW_{L,t}\big) - \beta\, dt. \tag{37}$$

## *D. Equilibrium*

This section studies the equilibrium properties of proof of stake blockchains in the presence of liquid staking tokens as a vehicle for value creation. Given exogenous productivity shocks $W_D$ and $W_L$, issuance policy $I$, and initial conditions for $\{P_t, Q_t, D_t, L_t, S_t\}$, a competitive equilibrium consists of portfolio allocations $\{(\theta_t^i)_{t\geq 0}, (\varphi_t^i)_{t\geq 0}\}$, consumption plans $(c_t^i)_{t\geq 0}$, and prices $(P_t)_{t\geq 0}$ such that all users maximize utility and markets clear.

The following result, which relies on arguments analogous to those in Proposition 2, characterizes the symmetric equilibrium.

PROPOSITION 4: *Token prices follow the dynamics in* (26) *with loadings*

$$\mu_{P,t} = \theta_t^\star \mu_D + \varphi_t^\star \mu_L - \beta - (1 - \theta_t^\star)\mu_{I,t}, \tag{38}$$

$$\sigma_{P,t} = \theta_t^\star \sigma_D, \tag{39}$$

$$\xi_{P,t} = \varphi_t^\star \xi_L, \tag{40}$$

*where* $\theta_t^\star$ *and* $\varphi_t^\star$ *denote equilibrium portfolio shares. If the allocation*

$$\theta_t^\star = \frac{1}{2(1-\rho^2)}\Big[\frac{\mu_D - \mu_{I,t}}{\sigma_D^2} - \rho\,\frac{\mu_L}{\sigma_D \xi_L}\Big], \qquad \varphi_t^\star = \frac{1}{2(1-\rho^2)}\Big[\frac{\mu_L}{\xi_L^2} - \rho\,\frac{\mu_D - \mu_{I,t}}{\sigma_D \xi_L}\Big], \tag{41}$$

*satisfies* $0 < \theta_t^\star$, $0 < \varphi_t^\star$, *and* $\theta_t^\star + \varphi_t^\star < 1$, *then it constitutes the unique equilibrium. If the interior allocation is not feasible, the equilibrium allocation maximizes welfare among the following candidates.*

1. *DeFi with LSTs only:* $\theta_t^\star = 0$ *and* $\varphi_t^\star = \min\Big\{\max\Big\{\frac{\mu_L}{2\xi_L^2}, 0\Big\}, 1\Big\}$.
2. *DeFi with native tokens only: coincides with the equilibrium in Proposition 2.*
3. *No staking:* $\theta_t^\star + \varphi_t^\star = 1$ *and*

$$\theta_t^\star = \frac{\mu_D - \mu_L - \mu_{I,t} - 2\xi_L(\rho\sigma_D - \xi_L)}{2(\sigma_D^2 + \xi_L^2 - 2\rho\sigma_D\xi_L)}.$$

**Allocation.** The equilibrium allocation is determined by DeFi productivity, risk, and issuance policy. Higher risk adjusted productivity of either asset increases its use in DeFi.

The key novelty relative to the baseline model without productive LSTs is the emergence of a corner equilibrium, corresponding to case 1 in Proposition 4. In this equilibrium, DeFi activity using native tokens disappears, and user allocations between LST based DeFi and staking become independent of issuance. As a result, the evolution of market capitalization in (37) is also independent of issuance.

In this regime, issuance delivers zero marginal returns to staking and no longer affects incentives, rendering the equilibrium insensitive to issuance.[3] In a blockchain economy where productive activity relies exclusively on LSTs, there is no mechanism through which the protocol can restore monetary non neutrality. Any issuance creates new tokens that are distributed symmetrically across users, eliminating the redistribution channel through which issuance affected portfolio choice in Section II.

In a blockchain economy with LSTs, security is provided through both LST based and pure staking. The model does not distinguish between solo staking and delegated liquid

[3] In an extended model with slashing applied to staking returns, even slashing would fail to affect incentives when all productive activity is conducted through LSTs.

staking, that is holding LSTs outside of DeFi. If the convenience of LSTs causes delegated staking to dominate solo staking, security provision and consensus may become concentrated in the hands of liquid staking protocols, which are centralized entities. In the equilibrium described above, issuance plays no role in attracting stakers. Validators provide security in order to gain exposure to DeFi productivity rather than to issuance rewards.

As discussed in Section III.E, issuance reduces the attractiveness of DeFi with native tokens and encourages adoption of LSTs as the primary vehicle for productive activity. This effect is amplified when the productivity of LSTs and native tokens is highly correlated, so that DeFi activity using both becomes increasingly similar. Strategic complementarities further amplify this mechanism and push the economy toward full LST adoption and monetary neutrality.

**Token prices.** Token prices reflect two components. The first component is the discounted value $\theta_t^\star \mu_D + \varphi_t^\star \mu_L - \beta$ of productive native tokens and productive LSTs. The second component is the dilution effect $(1 - \theta_t^\star)\mu_{I,t}$ induced by issuance. Price volatility in (17) reflects fundamental productivity risk from both assets, scaled by the equilibrium shares of wealth invested in each vehicle.

## *E. Policy and LSTs*

**Effect of issuance.** Figure 2 illustrates the equilibrium allocation between native tokens and LSTs as vehicles for productive activity when both assets have identical risk adjusted productivity. At low issuance rates, imperfect correlation between productivity shocks induces users to diversify across the two tokens. Issuance enters returns positively for LSTs and pure staking, but negatively for native tokens that bear the issuance tax. As issuance increases, DeFi activity with native tokens becomes progressively less attractive.

As in the baseline model, low issuance rates initially increase the dollar returns of stakers and LST holders. At higher issuance rates, the contraction of native token participation in DeFi reduces the productive base so sharply that effective returns decline.

Beyond a threshold, the equilibrium shifts toward full adoption of LSTs as the sole productive asset. Unlike the baseline model, productive activity does not vanish in this regime. LSTs remain productive and native token prices continue to adjust, so stakers remain exposed to price fluctuations and do not earn zero returns. More importantly, issuance policy no longer affects equilibrium allocations, and security provision may become increasingly centralized. This effect persists even when native tokens exhibit higher risk adjusted productivity. In that case, a higher issuance rate is required for full adoption of LSTs, as illustrated in Figure 3.

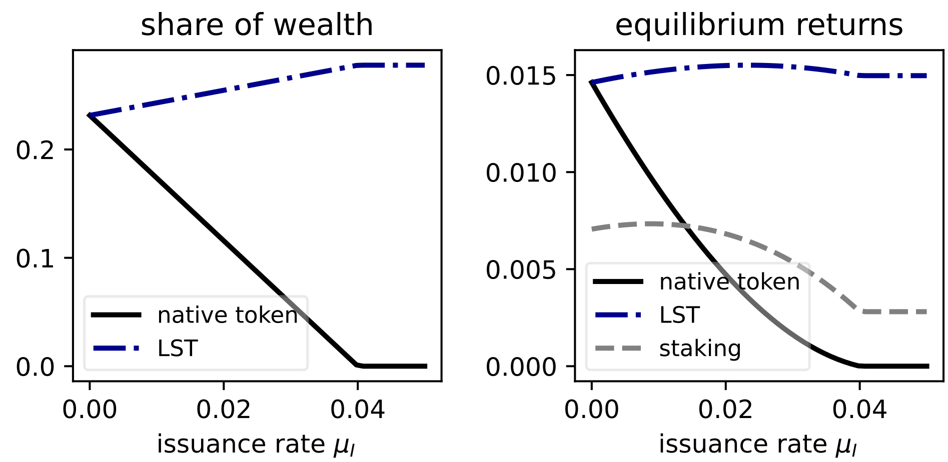


**Figure 2.** Left panel: equilibrium allocations to DeFi using native tokens, $\theta^\star$, and to DeFi using LSTs, $\varphi^\star$, as functions of the issuance rate. Right panel: dollar returns, expressed relative to token capitalization $P_t Q_t$, to DeFi with native tokens, DeFi with LSTs, and staking. Model parameters are $\mu_D = \mu_L = 5\%$, $\sigma_D = \xi_L = 30\%$, $\beta = 1\%$, and $\rho = 20\%$.

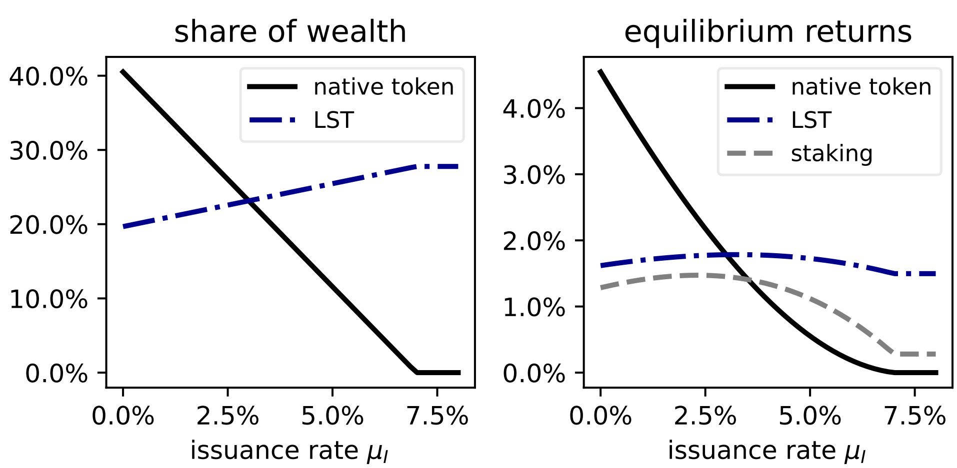


**Figure 3.** Left panel: equilibrium allocations to DeFi using native tokens, $\theta^\star$, and to DeFi using LSTs, $\varphi^\star$, as functions of the issuance rate. Right panel: dollar returns, expressed relative to token capitalization $P_t Q_t$, to DeFi with native tokens, DeFi with LSTs, and staking. Model parameters are $\mu_D = 5\%$, $\mu_L = 8\%$, $\sigma_D = 30\%$, $\xi_L = 40\%$, $\beta = 1\%$, and $\rho = 20\%$.

**Effect of correlation.** We interpret a higher correlation as LSTs granting access to a broader set of DeFi investment opportunities, potentially expanded through mechanisms such as restaking. As correlation increases, the diversification benefit between native tokens and LSTs weakens. When productivity shocks become more similar, joint exposure provides less risk reduction, which lowers equilibrium allocations to each asset.

Figure 4 illustrates this mechanism when native tokens and LSTs have identical risk adjusted productivity. When correlation is low, issuance leads users to allocate more wealth to LSTs than to native tokens. As correlation rises, equilibrium allocations to DeFi with both assets initially decline as diversification benefits erode. Beyond a threshold, users optimally concentrate productive investment entirely in LSTs. Past this point, users increase exposure to LST based DeFi to reach their desired risk level, since native tokens no longer offer additional diversification benefits and are abandoned.

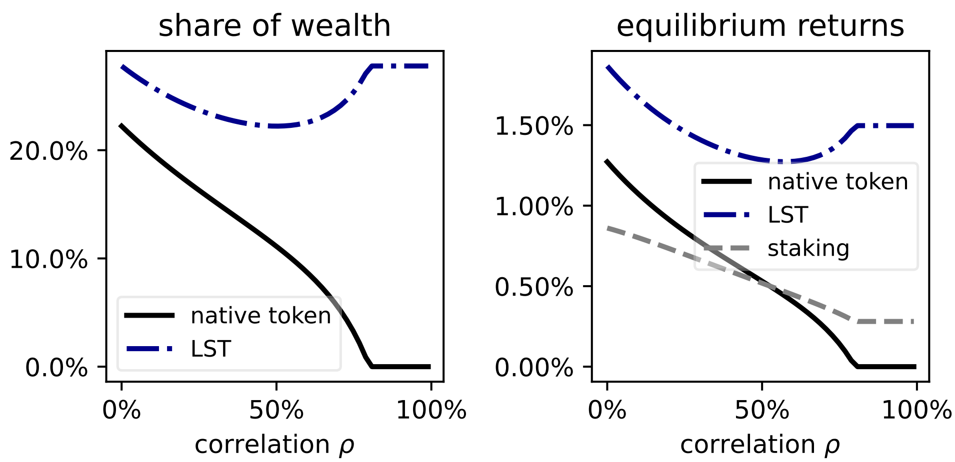


**Figure 4.** Left panel: equilibrium allocations to DeFi using native tokens, $\theta^{\star}$, and to DeFi using LSTs, $\varphi^{\star}$, as functions of the correlation $\rho$ of the productivity rates of both token types. Right panel: dollar returns, expressed relative to token capitalization $P_t Q_t$, to DeFi with native tokens, DeFi with LSTs, and staking. Model parameters are $\mu_D = \mu_L = 5\%$, $\sigma_D = \xi_L = 30\%$, $\beta = 1\%$, and $\mu_I = 0.3\%$.

However, when the risk-adjusted return of DeFi with native tokens is sufficiently higher than that of DeFi with LSTs and issuance is low, an increase in correlation has the opposite effect, as illustrated in Figure 5. In this case, higher correlation shifts the equilibrium toward full adoption of native tokens as a productive tool, as characterized in Proposition 4. This does not imply that liquid staking protocols cease to exist, but rather that LSTs are used solely as delegated staking instruments, not as derivative tokens for generating value.

More generally, Proposition 4 provides conditions that are useful for blockchain governance to assess when increased adoption of LSTs in DeFi, captured in our model by rising correlation, poses a threat to the effectiveness of issuance-based policy.

Finally, Figure 6 illustrates a key implication of increased LST adoption in DeFi. As LSTs become more widely used for productive activity, the correlation between LST and native-token productivity rises, shrinking the set of issuance policies that can be implemented in equilibrium. Intuitively, as productive opportunities migrate toward LSTs, issuance becomes

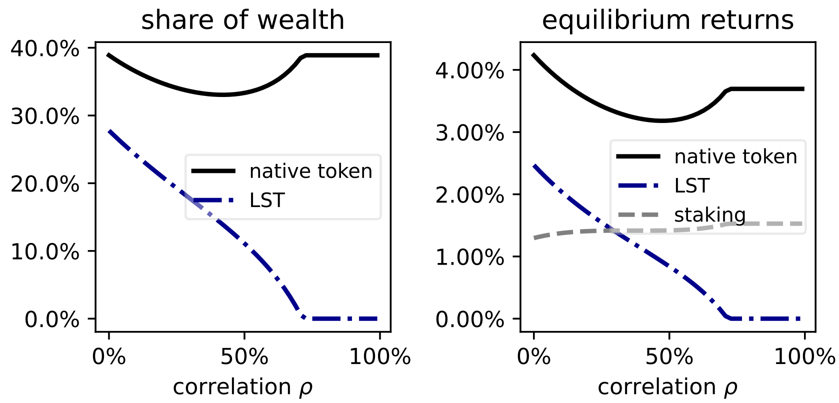


**Figure 5.** Equilibrium allocations to DeFi using native tokens, $\theta^\star$, and to DeFi using LSTs, $\varphi^\star$, as functions of the correlation $\rho$ of the productivity rates of both token types. Model parameters are $\mu_D = \mu_L = 5\%$, $\sigma_D = 30\%$, $\xi_L = 40\%$, $\beta = 1\%$, and $\mu_I = 0.3\%$.

the primary, and eventually the only, dimension along which native tokens differ from LSTs. Since issuance weakens incentives to hold native tokens in DeFi, higher correlation compresses the feasible range of issuance rates, forcing the protocol to operate within a narrower policy space.

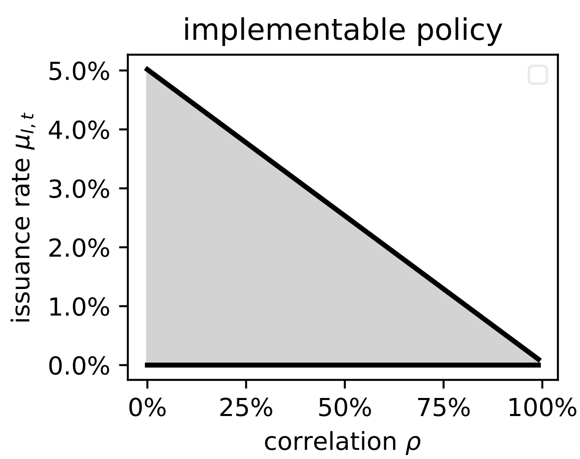


**Figure 6.** Range of possible implementable issuance by the blockchain which lead to non-zero native token holdings and monetary non-neutrality. This range is shown as function of the correlation $\rho$ of the productivity rates of both token types. Model parameters are $\mu_D = \mu_L = 5\%$, $\sigma_D = \xi_L = 35\%$, and $\beta = 1\%$.

## F. Strategic complementarity and the cost of liquidity

In this section, each user anticipates that the cost of using DeFi with either native tokens or LSTs decreases with the aggregate dollar scale of that activity, measured by $D_t$ and $L_t$. Let $c : [0, \infty) \to [0, 1)$ denote a (decreasing) cost function that maps the aggregate scale of circulating tokens into an effective proportional cost wedge associated with productive use.

As before, let $D_t$ denote the dollar value of productive native tokens, $L_t$ the dollar value of productive LSTs, and $S_t$ the dollar value of staked tokens. DeFi activity conducted with native tokens generates stochastic dollar productivity and is subject to token price changes. Its dollar return is

$$\frac{d\nu_{D,t}}{\nu_{D,t}} = \underbrace{\mu_D\, dt + \sigma_D\, dW_{D,t}}_{\text{productivity}} - \underbrace{c\left(\frac{D_t}{P_t Q_t}\right)}_{\text{costs}} + \underbrace{\frac{dP_t}{P_t}}_{\text{token price changes}} . \tag{42}$$

Similarly, the return to DeFi activity conducted with LSTs is

$$\frac{d\nu_{L,t}}{\nu_{L,t}} = \underbrace{\mu_L\, dt + \xi_L\, dW_{L,t}}_{\text{productivity}} - \underbrace{c\left(\frac{L_t}{P_t Q_t}\right)}_{\text{costs}} + \underbrace{\frac{dP_t}{P_t}}_{\text{token price changes}} , \tag{43}$$

while the return to pure staking is as defined in (25).

The expressions in (42) and (43) show that portfolio choice depends on the aggregate scale of productive native tokens and productive LSTs. Anticipated usage costs therefore generate strategic complementarities. As more users concentrate on one productive option, its effective cost declines, which reinforces further adoption. These complementarities can equivalently be interpreted as additional productivity that increases with the aggregate scale of productive tokens.

Token prices follow the dynamics in (26). Since blockchain users make symmetric portfolio choices, we drop the index $i$. The interior portfolio allocation, subject to feasibility, satisfies

$$\theta_t^\star = \frac{1}{(1-\rho^2)\sigma_D^2}\left[\mu_D - c\left(\frac{D_t}{P_t\, Q_t}\right) - \mu_{I,t} - \rho\,\frac{\sigma_D}{\xi_L}\left(\mu_L - c\left(\frac{L_t}{P_t\, Q_t}\right)\right)\right] - \frac{\sigma_P}{\sigma_D}, \tag{44}$$

$$\varphi_t^i = \frac{1}{(1-\rho^2)\xi_L^2}\left[\mu_L - c\left(\frac{L_t}{P_t\, Q_t}\right) - \rho\,\frac{\xi_L}{\sigma_D}\left(\mu_D - \mu_{I,t} - c\left(\frac{D_t}{P_t\, Q_t}\right)\right)\right] - \frac{\xi_{P,t}}{\xi_L} . \tag{45}$$

Following the same steps as above, interior equilibrium allocations to DeFi with native tokens and to DeFi with LSTs satisfy the fixed point system

$$\theta^{\star} = \frac{1}{2\,(1-\rho^2)\sigma_D^2}\left[\mu_D - c\,(\theta_t^{\star}) - \mu_{I,t} - \rho\,\frac{\sigma_D}{\xi_L}\,(\mu_L - c\,(\varphi_t^{\star}))\right],$$
$$\varphi_t^{\star} = \frac{1}{2\,(1-\rho^2)\xi_L^2}\left[\mu_L - c\,(\varphi_t^{\star}) - \rho\,\frac{\xi_L}{\sigma_D}\,(\mu_D - \mu_{I,t} - c\,(\theta_t^{\star}))\right].$$

Token price dynamics follow (26) with equilibrium loadings

$$\mu_{P,t} = \theta_t^{\star}\;(\mu_D - c\,(\theta_t^{\star})) + \varphi_t^{\star}\;(\mu_L - c\,(\varphi_t^{\star})) - (1-\theta_t^{\star})\;\mu_{I,t} - \beta\,,$$
$$\sigma_{P,t} = \theta_t^{\star}\,\sigma_D\,,$$
$$\xi_{L,t} = \varphi_t^{\star}\,\xi_L\,.$$

To assess the implications of strategic complementarities, we adopt the parametric specification $c(x) = a(b-x)$ for the cost function and solve for the full equilibrium as in Proposition 4. We reproduce Figures 2 and 4, now incorporating anticipated liquidity costs. Strategic complementarities amplify the effects of issuance and correlation, making the equilibrium in which productive activity relies exclusively on LSTs easier to attain. In this regime, issuance no longer affects incentives.

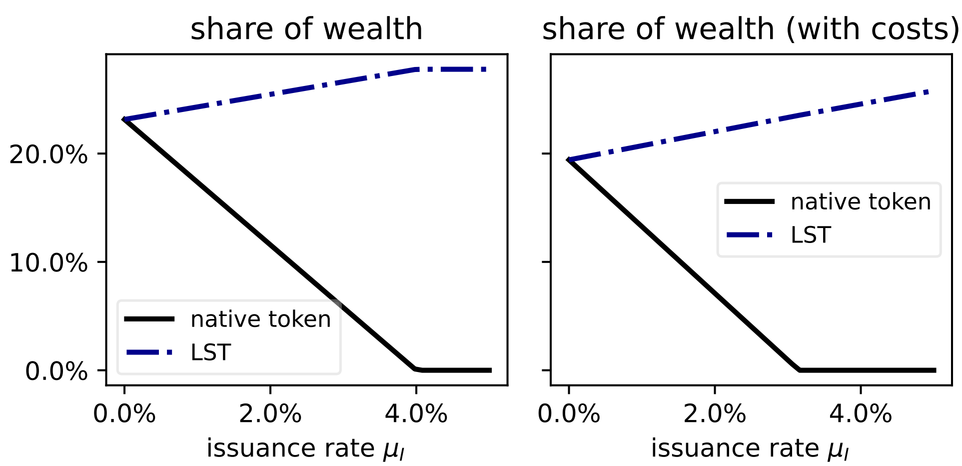


**Figure 7.** Equilibrium allocations to DeFi using native tokens, $\theta^{\star}$, and to DeFi using LSTs, $\varphi^{\star}$, as functions of the issuance rate. The issuance rate is expressed relative to native-token productivity, $\mu_I/\mu_D$. Model parameters are $\mu_D = \mu_L = 5\%$, $\sigma_D = \xi_L = 35\%$, $\beta = 1\%$, $\rho = 20\%$, $a = 0.005$, and $b = 1$. Left panel: without liquidity costs. Right panel: with liquidity costs.

Figure 7 illustrates how anticipated usage costs alter equilibrium allocations between native tokens and LSTs in DeFi. Users become less tolerant to issuance for two related reasons. First, issuance directly weakens returns to native token DeFi and, by reducing its scale, endogenously raises usage costs $c(\theta_t)$. What appears as a first order tax in the baseline model becomes a higher order distortion once liquidity effects are anticipated. As a result, usage costs erode the diversification benefits of native tokens more rapidly.

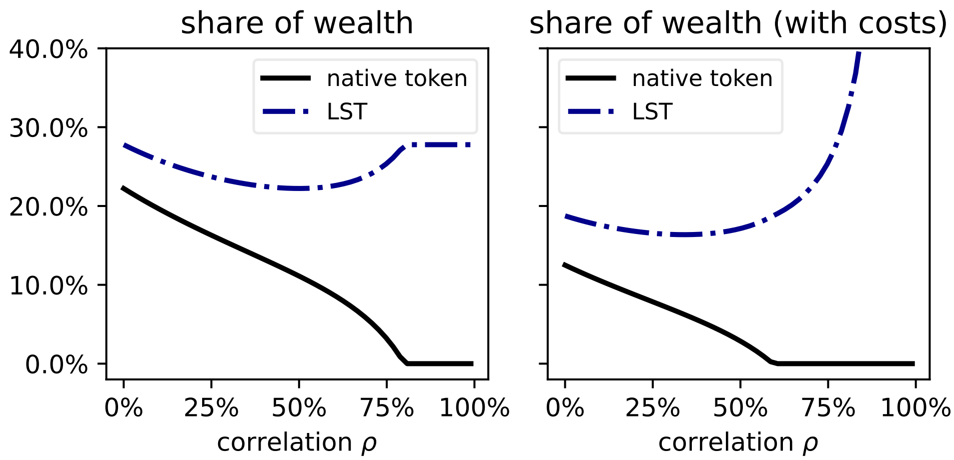


**Figure 8.** Equilibrium allocations to DeFi using native tokens, $\theta^{\star}$, and to DeFi using LSTs, $\varphi^{\star}$, as functions of the correlation $\rho$ of the productivity rates of both token types. Model parameters are $\mu_D = \mu_L = 5\%$, $\sigma_D = \xi_L = 35\%$, $\beta = 1\%$, $\mu_I = 0.3\%$, $a = 0.005$, and $b = 1$. Left panel: without liquidity costs. Right panel: with liquidity costs.

Figure 8 shows that users are substantially less tolerant to increases in correlation between the productivity of native tokens and LSTs. Higher correlation further weakens diversification benefits. As a result, strategic complementarities compress the set of issuance policies that can be implemented in equilibrium.

# IV. Conclusion

This paper studies issuance policy in proof-of-stake blockchains through the lens of a dynamic equilibrium model that makes explicit the interaction between productivity, security incentives, and financial innovation. In the absence of liquid staking, issuance redistributes value from productive on-chain activity to validators and thereby finances security through a distortionary tax on production. This structure imposes an endogenous constraint on issuance-based policy: while higher issuance can initially raise staking revenues, excessive issuance contracts the productive base that sustains them. The resulting Laffer-curve relationship highlights that staking incentives are ultimately anchored in economic activity rather than created mechanically through token supply expansion.

Introducing liquid staking fundamentally alters this transmission mechanism. By allowing users to earn staking rewards while remaining productive, liquid staking weakens the link between issuance and portfolio choice and shifts adjustment away from the level of on-chain activity toward its composition. When liquid staking tokens are close substitutes for the native asset and benefit from endogenous liquidity effects, equilibrium allocations can become largely insensitive to issuance and slashing, with productive activity migrating away from the native token and security provision becoming increasingly intermediated. More broadly, the analysis illustrates a general limit of decentralized monetary policy: when financial innovation allows agents to bypass policy-induced distortions, traditional incentive tools lose traction. Understanding this interaction between protocol design, financial structure, and policy effectiveness is central to the long-run security and decentralization of proof-of-stake systems.

# Appendix A. Proofs

## *Appendix A. Proof of Proposition 1*

Fix a user $i \in [0,1]$ and hold the aggregate objects $P_t, Q_t, D_t, S_t$ and the price loadings $\mu_{P,t}, \sigma_{P,t}$ and the issuance process $\mu_{I,t}$ as given. Omit the time index when no confusion arises.

The dollar net worth $x_t^i$ of user $i$ evolves according to

$$\frac{dx_t^i}{x_t^i} = \theta_t^i \frac{d\nu_{D,t}}{\nu_{D,t}} + (1-\theta_t^i)\frac{d\nu_{S,t}}{\nu_{S,t}} - c_t^i\, dt.$$

Substitute the asset returns (4), (7) and the price dynamics (3). Using $dI_t/I_t = \mu_{I,t}\, dt$ we obtain

$$\frac{dx_t^i}{x_t^i} = \left[\mu_{P,t} + \theta_t^i \mu_D + (1-\theta_t^i)\mu_{I,t} - \frac{c_t^i}{x_t^i}\right] dt + \left(\theta_t^i \sigma_D + \sigma_{P,t}\right) dW_{D,t}.$$

Let $V(x)$ denote the value function of the representative infinitesimal user. The Hamilton Jacobi Bellman equation is

$$\beta V(x) = \max_{c \geq 0,\ \theta \in [0,1]} \left\{ \log c + V_x x \left[\mu_{P,t} + \theta\mu_D + (1-\theta)\mu_{I,t} - \frac{c}{x}\right] + \frac{1}{2} V_{xx} x^2 (\theta\sigma_D + \sigma_{P,t})^2 \right\}.$$

Adopt the standard log utility ansatz

$$V(x) = K + \frac{1}{\beta}\log x.$$

Then $V_x = \frac{1}{\beta x}$ and $V_{xx} = -\frac{1}{\beta x^2}$. The first order condition with respect to $c$ is $1/c - 1/(\beta x) = 0$, which yields the optimal consumption rule

$$c_t^{i\star} = \beta x_t^i.$$

Substituting $c = \beta x$ into the HJB and canceling common terms reduces the remaining maximization to choosing $\theta \in [0,1]$ to maximize the concave objective

$$G(\theta) = \mu_{P,t} + \theta\mu_D + (1-\theta)\mu_{I,t} - \tfrac{1}{2}(\theta\sigma_D + \sigma_{P,t})^2.$$

Discarding constants that do not affect the maximizer, this is equivalent to

$$\widetilde{G}(\theta) = \theta(\mu_D - \mu_{I,t}) - \tfrac{1}{2}\sigma_D^2\theta^2 - \theta\sigma_D\sigma_{P,t}.$$

The second derivative is $\widetilde{G}''(\theta) = -\sigma_D^2 < 0$, so the objective is strictly concave and admits at most one interior stationary point.

**Interior first order condition and solution.** For an interior maximizer $0 < \theta^\star < 1$ the first order condition is

$$0 = \widetilde{G}'(\theta^\star) = \mu_D - \mu_{I,t} - \sigma_D^2 \theta^\star - \sigma_D \sigma_{P,t}.$$

Rearranging gives the interior candidate

$$\theta^\star = \frac{\mu_D - \mu_{I,t} - \sigma_D \sigma_{P,t}}{\sigma_D^2},$$

which coincides with (9).

**Corner solutions.** If the interior candidate is not feasible it must be projected to the constraint set $[0, 1]$. Thus $\theta^\star \leq 0$ implies the constrained optimum is $\theta^\star = 0$ and this occurs exactly when

$$\mu_D - \mu_{I,t} - \sigma_D \sigma_{P,t} \leq 0 \quad \Longleftrightarrow \quad \mu_{I,t} \geq \mu_D - \sigma_D \sigma_{P,t}.$$

Similarly $\theta^\star \geq 1$ implies the constrained optimum is $\theta^\star = 1$ and this occurs exactly when

$$\frac{\mu_D - \mu_{I,t} - \sigma_D \sigma_{P,t}}{\sigma_D^2} \geq 1 \quad \Longleftrightarrow \quad \mu_{I,t} \leq \mu_D - \sigma_D^2 - \sigma_D \sigma_{P,t}.$$

**Uniqueness.** Strict concavity of $\widetilde{G}$ implies that the interior candidate, when feasible, is the unique global maximizer. When infeasible, projection onto the boundary yields the unique constrained maximizer. This completes the proof. □

## *Appendix B. Proof of Proposition 2*

Start from the market clearing identities (10)–(14). Omit time subscripts when no confusion arises. By Ito's product rule,

$$d(P_t Q_t) = Q_t \, dP_t + P_t \, dQ_t + d\langle P, Q \rangle_t.$$

Since $dQ_t/Q_t = (1 - \theta_t^\star)\mu_{I,t} \, dt$ contains no martingale term, the quadratic covariation vanishes. Dividing by $P_t Q_t$ and using (3) and (14) yields

$$\frac{d(P_t Q_t)}{P_t Q_t} = \mu_{P,t} \, dt + \sigma_{P,t} \, dW_{D,t} + (1 - \theta_t^\star)\mu_{I,t} \, dt. \tag{A1}$$

Aggregate wealth dynamics in (15) write

$$\frac{d(P_tQ_t)}{P_tQ_t} = \theta_t^\star\big(\mu_D\,dt + \sigma_D\,dW_{D,t}\big) - \beta\,dt.$$

Matching the martingale parts in this expression and in (A1) gives the volatility identity

$$\sigma_{P,t} = \theta_t^\star\,\sigma_D.$$

Substituting this identity back into (A1) and equating drifts yields

$$\mu_{P,t} + (1-\theta_t^\star)\mu_{I,t} = \theta_t^\star\mu_D - \beta,$$

which rearranges to the stated drift formula. Next, use the interior candidate from Proposition 1,

$$\theta_t^\star = \frac{\mu_D - \mu_{I,t} - \sigma_D\sigma_{P,t}}{\sigma_D^2}.$$

Replace $\sigma_{P,t} = \theta_t^\star\sigma_D$ to obtain

$$\theta_t^\star = \frac{\mu_D - \mu_{I,t} - \sigma_D^2\theta_t^\star}{\sigma_D^2}.$$

Rearranging gives the interior equilibrium allocation

$$\theta_t^\star = \frac{\mu_D - \mu_{I,t}}{2\sigma_D^2},$$

as claimed in (18).

**Corner cases and uniqueness.** The objective for the representative user is strictly concave in $\theta$ so the interior candidate is the unique maximizer whenever it lies in $(0,1)$. If the candidate is not feasible, the constrained maximizer is its projection onto $[0,1]$. Thus $\theta_t^\star \le 0$ implies the equilibrium is $\theta_t^\star = 0$, which occurs exactly when

$$\mu_D - \mu_{I,t} \le 0.$$

Similarly $\theta_t^\star \ge 1$ implies the equilibrium is $\theta_t^\star = 1$, which occurs when

$$\frac{\mu_D - \mu_{I,t}}{2\sigma_D^2} \ge 1 \quad \Longleftrightarrow \quad \mu_{I,t} \le \mu_D - 2\sigma_D^2.$$

□

## *Appendix C. Proof of Proposition 3.*

Fix a user $i \in [0,1]$. Drop explicit time indices when no ambiguity arises. Using (23), (24) and (25) together with the price dynamics (26), the three asset returns can be written as

$$\begin{aligned}
\frac{d\nu_{D,t}}{\nu_{D,t}} &= (\mu_D + \mu_{P,t})\, dt + (\sigma_D + \sigma_{P,t})\, dW_{D,t} + \xi_{P,t}\, dW_{L,t}, \\
\frac{d\nu_{L,t}}{\nu_{L,t}} &= (\mu_L + \mu_{I,t} + \mu_{P,t})\, dt + \sigma_{P,t}\, dW_{D,t} + (\xi_L + \xi_{P,t})\, dW_{L,t}, \\
\frac{d\nu_{S,t}}{\nu_{S,t}} &= (\mu_{I,t} + \mu_{P,t})\, dt + \sigma_{P,t}\, dW_{D,t} + \xi_{P,t}\, dW_{L,t}.
\end{aligned}$$

A user holding fractions $\theta$ in native token DeFi, $\varphi$ in LST DeFi, and the remainder in staking has dollar wealth dynamics

$$\frac{dx_t^i}{x_t^i} = \left[\mu_{P,t} + \theta\mu_D + \varphi\mu_L + (1-\theta)\mu_{I,t} - \frac{c_t^i}{x_t^i}\right] dt + (\theta\sigma_D + \sigma_{P,t})\, dW_{D,t} + (\varphi\xi_L + \xi_{P,t})\, dW_{L,t}.$$

Let $V(x)$ be the value function. The HJB is

$$\begin{aligned}
\beta V(x) = \max_{c\geq 0,\, (\theta,\varphi)\in\mathcal{S}} \Bigg\{ &\log c + V_x x \left[\mu_{P,t} + \theta\mu_D + \varphi\mu_L + (1-\theta)\mu_{I,t} - \frac{c}{x}\right] \\
&+ \tfrac{1}{2} V_{xx} x^2 \left[(\theta\sigma_D + \sigma_{P,t})^2 + (\varphi\xi_L + \xi_{P,t})^2 + 2\rho(\theta\sigma_D + \sigma_{P,t})(\varphi\xi_L + \xi_{P,t})\right] \Bigg\},
\end{aligned}$$

where $\mathcal{S} = \{(\theta,\varphi) : 0 \leq \theta,\ 0 \leq \varphi,\ \theta + \varphi \leq 1\}$ is the feasible set. Using the log utility ansatz $V(x) = K + \frac{1}{\beta}\log x$ gives $V_x = \frac{1}{\beta x}$ and $V_{xx} = -\frac{1}{\beta x^2}$. The FOC for consumption yields

$$c_t^{i\star} = \beta x_t^i.$$

Substituting $c = \beta x$ and canceling constants reduces the choice of $(\theta,\varphi) \in \mathcal{S}$ to the concave maximization of

$$\begin{aligned}
G(\theta,\varphi) = {} & \mu_{P,t} + \theta\mu_D + \varphi\mu_L + (1-\theta)\mu_{I,t} \\
& - \tfrac{1}{2}\left[(\theta\sigma_D + \sigma_{P,t})^2 + (\varphi\xi_L + \xi_{P,t})^2 + 2\rho(\theta\sigma_D + \sigma_{P,t})(\varphi\xi_L + \xi_{P,t})\right].
\end{aligned}$$

Strict concavity follows because the covariance matrix of the Brownian shocks is positive definite and $|\rho| < 1$. For an interior maximizer $(\theta^\star, \varphi^\star)$ the FOCs $\partial_\theta G = 0$ and $\partial_\varphi G = 0$ read

$$
\begin{aligned}
0 &= \mu_D - \mu_{I,t} - (\theta^\star \sigma_D + \sigma_{P,t})\sigma_D - \rho\, \sigma_D(\varphi^\star \xi_L + \xi_{P,t}), \\
0 &= \mu_L - (\varphi^\star \xi_L + \xi_{P,t})\xi_L - \rho\, \xi_L(\theta^\star \sigma_D + \sigma_{P,t}),
\end{aligned}
$$

and yields the interior solution

$$
\begin{aligned}
\theta_t^\star &= \frac{1}{(1-\rho^2)\sigma_D^2}\Big(\mu_D - \mu_{I,t} - \rho\, \frac{\sigma_D}{\xi_L}\mu_L\Big) - \frac{\sigma_{P,t}}{\sigma_D}, \\
\varphi_t^\star &= \frac{1}{(1-\rho^2)\xi_L^2}\Big(\mu_L - \rho\, \frac{\xi_L}{\sigma_D}(\mu_D - \mu_{I,t})\Big) - \frac{\xi_{P,t}}{\xi_L},
\end{aligned}
$$

which coincides with (28).

If the interior candidate is infeasible the unique maximizer lies on the boundary of $\mathcal{S}$. The three relevant corners are handled next.

**Corner case 1** (DeFi with LSTs only). Set $\theta = 0$ and maximize $G(0, \varphi)$ over $0 \le \varphi \le 1$. Up to constants,

$$
G(0, \varphi) = \varphi \mu_L - \tfrac{1}{2}(\varphi \xi_L + \xi_{P,t})^2 - \rho\, \sigma_{P,t}(\varphi \xi_L + \xi_{P,t}).
$$

The FOC is

$$
\mu_L - (\varphi \xi_L + \xi_{P,t})\xi_L - \rho\, \sigma_{P,t}\xi_L = 0,
$$

hence the unconstrained candidate is

$$
\varphi^\star = \frac{\mu_L - \xi_L(\xi_{P,t} + \rho \sigma_{P,t})}{\xi_L^2}.
$$

Projecting this candidate onto $[0, 1]$ yields the constrained maximizer in (29).

**Corner case 2** (DeFi with native tokens only). Set $\varphi = 0$. This case reduces to the single risky asset problem solved in Proposition 1.

**Corner case 3** (no staking). Set $\varphi = 1 - \theta$ and maximize $G(\theta, 1-\theta)$ over $0 \le \theta \le 1$. Note that the issuance term vanishes on this corner, the FOC after rearrangement yields

$$
\theta\big(\sigma_D^2 + \xi_L^2 - 2\rho \sigma_D \xi_L\big) = \mu_D - \mu_L - \mu_{I,t} - \big((\sigma_D - \rho \xi_L)\sigma_{P,t} + (\rho \sigma_D - \xi_L)(\xi_{P,t} + \xi_L)\big).
$$

Solving for $\theta$ gives the expression in (30). Projecting into $[0, 1]$ provides the feasible maximizer on this face.

**Selection and uniqueness.** Strict concavity of $G$ guarantees that the interior candidate, when feasible, is the unique global maximizer. When it is infeasible, comparison of objective values on the three corner cases yields the unique global maximizer. □

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