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A Unified Mathematical-Economic Framework of Rincoin with Customizable Emission Schedules (Preliminary)

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Abstract. Current blockchain ecosystems confront two fundamental threats: proof-of-work (PoW) networks suffer from excessive energy consumption and limited sustainability, while proof-of-stake (PoS) platforms experience validator centralisation driven by governments and large stakeholders. Consequently, a four-fold dilemma decentralisation, security, scalability, and sustainability the "tetra-lemma" has emerged.

This paper uses Rincoin as a case study and aims to present a rigorous mathematical framework together with several consensus mechanisms design capable of overcoming the tetra-lemma. First, we develop a Customized Halving model that formalises long-term token-supply dynamics and inflation stability. Second, we will propose a new consensus which is resilient against centralized pressure, and we plan to explain it in the next major update. Finally, we introduce a specialized consensus mechanism, demonstrating theoretically that decentralisation, security, scalability, and sustainability can be efficiently addressed and simultaneously, which will also be explained in the next major update.

These findings provide a concrete blueprint for building blockchains that resolve the tetra-lemma.

Keywords: cryptocurrency, emission schedule, halving mechanism, supply stability, inflation modeling, mathematical framework, tokenomics, Rincoin ordinals token, blockchain security

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1 Introduction

In recent years, blockchain networks have been confronted with the well-known trilemma of decentralisation (fairness), security, and scalability[1]. Proof-of-Work (PoW) cryptocurrencies such as Bitcoin maintain decentralization and scarcity through a predetermined issuance schedule, which simultaneously provides mining incentives [2]. The canonical halving mechanism has historically driven price appreciation while reducing miners' block-reward revenue, thereby raising concerns about long-term network security. Although higher prices have partially offset this revenue decline [3, 4], the eventual transition to a zero-issuance regime poses a structural risk to security already approaching critical limits [5].

At present, transaction fees only a modest portion—typically represents a few percent—of total block rewards, which is insufficient to sustain the network without additional issuance. Removing the supply cap or introducing a "tail-emission" would therefore be highly contentious, as such measures clash with Bitcoin's core philosophical tenets [6]. Bitcoin's standard halving mechanism has facilitated price appreciation while exerting downward pressure on miners' revenues, potentially compromising network security. Nevertheless, this impact has been mitigated by the resultant increase in price[3][4].

However, Bitcoin's halving mechanism, while designed to enhance scarcity, ultimately results in zero issuance, posing a potential threat to network security[5]. This concern is amplified by the fact that miners' profit margins are already approaching critical limits. Currently, transaction fees constitute only a small fraction—typically a few percent—of block rewards, rendering them insufficient to sustain blockchain operations independently. Addressing this challenge by removing the supply cap or implementing tail emission would be highly contentious, as such measures conflict with Bitcoin's core philosophical principles[6].

Ethereum, which emerged after Bitcoin, expanded the blockchain paradigm by enabling Turing-complete smart contracts and supporting complex decentralized applications [7]. While Layer-2 solutions aim to mitigate scalability bottlenecks, the shift to Proof-of-Stake (PoS) consensus has introduced new centralisation vectors: validator sets have become more concentrated, and the protocol is increasingly exposed to regulatory pressures that could, in extreme scenarios, lead to effective control exceeding 51% [8, 9].

Rincoin addresses this challenge by introducing fixed rewards and a customized halving mechanism, aiming to achieve sustained stability while symbolically aligning with Bitcoin's supply cap multiplied by 8 (168 million RIN)[10, 11].

This paper derives mathematical models for supply and inflation rates by comparing an initial fixed-reward scenario with customized halving approaches. In this preliminary paper, defines the constants, model the supply functions, address general forms, and details the customized mechanism.

2 Basics of Rincoin Tokenomics

2.1 Definitions of Constants in the Baseline Scenario

$$
\begin{aligned}
B_y &= 525600 \quad \text{(Number of blocks per year, with block time } \approx 60, \mathrm{s}) \\
H &= 210000 \quad \text{(Number of blocks per halving)} \\
R_{w,0} &= 50 \quad \text{(Initial block reward (RIN))} \\
T_H &= 0.399543 \quad \text{(Halving interval (years))} \\
t_{fix} &= 2.796801 \quad \text{(Year when reward is fixed at 0.4 RIN, corresponding to 1,470,000 blocks)} \\
t_{trans} &= 702.778072 \quad \text{(The transition time at which the supply cap is reached and block rewards end)} \\
R_{w,fix} &= 0.4 \quad \text{(Fixed block reward (RIN/block))} \\
r_f &= B_y \times R_{w,fix} \quad \text{(Annual fixed supply increase)} \\
S_{fix} &= 20835937.5 \quad \text{(Cumulative supply at } t = t_{\text{fix}}) \\
C_{fix} &= 20376559.61 \quad \text{(Real circulating supply at } t = t_{fix}) \\
C_{peak} &= 20918226.57 \quad \text{(Real circulating supply at } t = t_{trans}) \\
D &= 0.99 \quad \text{(Annual retention rate, corresponding to 1\% loss)}
\end{aligned}
$$

2.2 Total Supply in the Baseline Scenario

The total supply $S(t)$ is derived as the solution to the following differential equation:

$$\frac{\partial S}{\partial t} = r(t), \quad S(0) = 0 \tag{1}$$

where $r(t)$ is the annual generation rate function, defined piecewise as follows:

$$r(t) = \begin{cases} B_y R_{w,0} \left(\frac{1}{2}\right)^k & (0 \leq t < t_{fix}) \\ r_f & (t_{fix} \leq t < t_{trans}) \\ 0 & (t \geq t_{trans}) \end{cases} \tag{2}$$

and $k = \left\lfloor \frac{t}{T_H} \right\rfloor$.

Equivalently, $S(t)$ can be expressed as

$$S(t) = \int_0^t r(t)\, dt \tag{3}$$

The closed-form expression for the total supply function of Rincoin in the baseline scenario, $S_B(t)$, with the block reward fixed at 0.4 RIN starting at $t = t_{fix}$, is given by:

$$S_B(t) = \begin{cases} 0 & (t = 0) \\ 2H \cdot R_{w,0} \cdot \left(1 - 0.5^k\right) \; + \; B_y \cdot R_{w,0}(t - T_H k) \cdot 0.5^k & (0 < t < t_{fix}) \\ S_{fix} + \frac{2}{5} B_y (t - t_{fix}) & (t_{fix} \leq t < t_{trans}) \\ 168000000 & (t \geq t_{trans}) \end{cases} \tag{4}$$

2.3 Real Circulating Supply in the Baseline Scenario

The real circulating supply $C(t)$ is derived as the solution to the following differential equation:

$$\frac{\partial C}{\partial t} = r(t) - \gamma C, \quad C(0) = 0 \tag{5}$$

where $\gamma = -\ln D \approx 0.01005$. The closed-form expression for $C_B(t)$, with the block reward fixed at 0.4 RIN starting at $t = t_{\text{fix}}$, is given by:

$$C_B(t) = \begin{cases} 0 & (t = 0) \\ \left(H \cdot R_{w,0} \cdot D^{t+\frac{T_H}{2}}\right)\dfrac{1-q^k}{1-q} \; + \; B_y \cdot R_{w,0} \cdot 0.5^k (t - T_H k) D^{t - T_H k - \frac{t - T_H k}{2}} & (0 < t < t_{\text{fix}}) \\ C_{fix} \cdot D^{t - t_{\text{fix}}} \; + \; \frac{2B_y/5}{1-D}\left(1 - D^{t-t_{\text{fix}}}\right) & (t_{\text{fix}} \leq t < t_{\text{trans}}) \\ C_{peak} \cdot D^{t - t_{\text{trans}}} & (t \geq t_{trans}) \end{cases} \tag{6}$$

where $k = \left\lfloor \frac{t}{T_H} \right\rfloor$ and $q = 0.5 D^{-T_H}$.

2.4 General Forms of the Total Supply and Real Circulating Supply

To generalize the expressions, we introduce the following additional constants:

$$\begin{aligned} \gamma &= -\ln D \quad \text{(Continuous loss rate)} \\ C^{\text{ss}} &= \frac{r_f}{\gamma} \quad \text{(Steady-state circulating supply during the fixed reward period)} \end{aligned}$$

The general form of the total supply $S_G(t)$ is:

$$S_G(t) = \begin{cases} 0 & (t = 0) \\ \displaystyle\sum_{j=0}^{k-1} H \cdot R_{w,0} \left(\frac{1}{2}\right)^j + B_y \cdot R_{w,0} (t - T_H k) \left(\frac{1}{2}\right)^k & (0 < t < t_{fix}) \\ S_{fix} + r_f (t - t_{fix}) & (t_{fix} \leq t < t_{trans}) \\ S_{max} & (t \geq t_{trans}) \end{cases} \tag{7}$$

where $S_{\max} = 168000000$, $k = \left\lfloor \frac{t}{T_H} \right\rfloor$, and the sum over the halving periods is equivalent to $2HR_{w,0}\left(1 - 0.5^k\right)$.

For the real circulating supply $C_G(t)$, the general form using continuous decay is:

$$C_G(t) = \begin{cases} 0 & (t = 0) \\ \displaystyle\sum_{j=0}^{k-1} H \cdot R_{w,0} \left(\frac{1}{2}\right)^j e^{-\gamma\left(t - T_H(j+0.5)\right)} \; + \; \frac{r_k}{\gamma}\left(1 - e^{-\gamma\left(t - T_H k\right)}\right) & (0 < t < t_{fix}) \\ C_{\text{fix}}\, e^{-\gamma(t - t_{fix})} \; + \; C^{\text{ss}}\left(1 - e^{-\gamma(t - t_{fix})}\right) & (t_{fix} \leq t < t_{\text{trans}}) \\ C_{\text{peak}}\, e^{-\gamma(t - t_{\text{trans}})} & (t \geq t_{\text{trans}}) \end{cases} \tag{8}$$

where $r_k = B_y \cdot R_{w,0} \left(\frac{1}{2}\right)^k$ is the annual supply increase in the current halving period. The discrete approximation using D (as in the previous section) serves as a midpoint approximation to the exponential decay, with $D^y \approx e^{-\gamma y}$. The form based on D is simpler for discrete annual calculations, whereas the exponential form provides greater precision for continuous models.

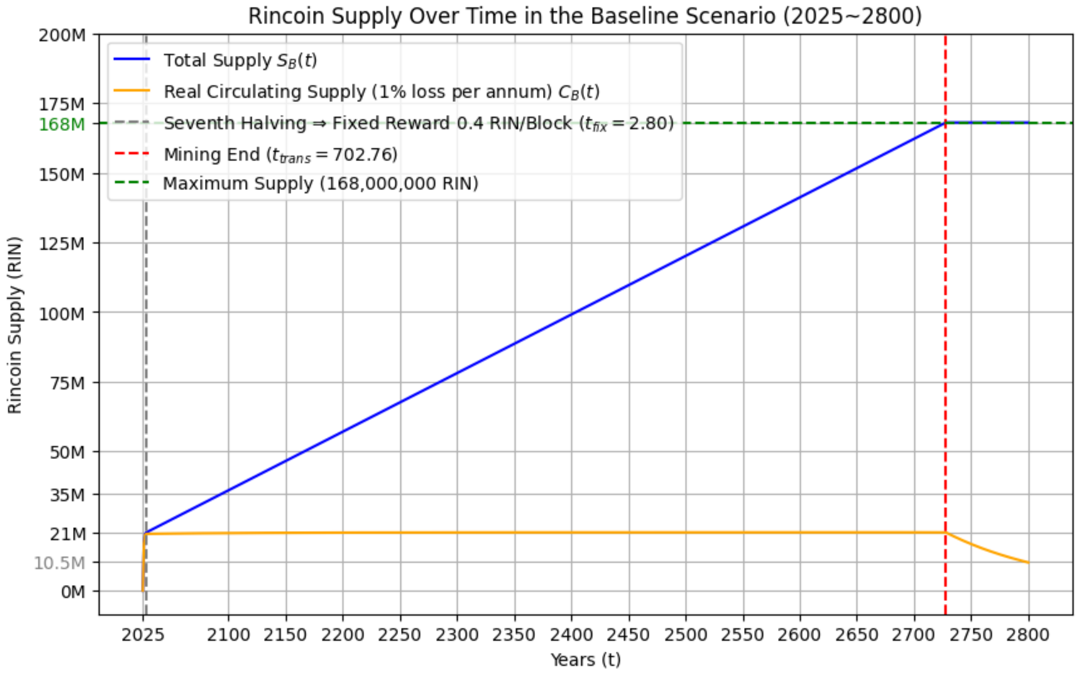

Figure 1: Rincoin supply over time in the baseline scenario (2025–2800). The total supply $S_B(t)$ (blue) increases until reaching the maximum of 168,000,000 RIN at $t \approx 702.76$. The real circulating supply $C_B(t)$ (orange) accounts for a 1% annual loss, peaking at $t \approx 702.76$ and declining thereafter. Key events include the seventh halving at $t \approx 2.80$ and the end of mining. Rincoin's effective circulating supply remains within the bounds of Bitcoin's maximum supply, enabling it to function as a virtual Bitcoin.

3 Customized Halving Mechanism

In the customized halving mechanism, after a specific halving, the halving period is changed by adjusting the halving reference block height and block reward. There are no rules regarding the halving period or block rewards after customization, and they can be set flexibly.

Basically, We first iterate the default halving model to approximate Bitcoin's initial issuance schedule of 2,500,000 Coin per year (10,000,000 Coin / 4 years). Rincoin has a block time that is 10 times faster than Bitcoin, so at the initial halving block height of 210,000, it will fall below 2,500,000 coins per year in the 840,000 block (about 1.6 years). Rincoin will set the final fixed block reward at 0.5 or 0.6 RIN/block, so by customizing the block reward to 4 RIN/block at 840,000 blocks and setting the next halving period to 2,100,000 blocks (remaining 2.4 year), we will replicate Bitcoin's initial emission schedule. In addition, it is a flexible model that allows you to temporarily fix at 1 RIN/block, which is one step before the final fixation stage of 0.5 or 0.6 RIN/block, and observe the situation.

These adaptive halving models were devised to balance the stabilization of mining rewards with the sustainability of the network.

3.1 General Framework for Customized Halving Models

In the general customized halving model, we define phases with varying block counts B_k and rewards R_k for $k = 0$ to K (where K is the total number of phases). Period durations are $T_k = B_k/B_y$, and cumulative years are $t_0 = 0$, $t_{k+1} = t_k + T_k$. Fixed-reward phases start at $t_{fix} = t_{k_f}$ (where k_f is the index of the first fixed phase), with potential multiple fixed phases (e.g., at 1 RIN/block for extended periods).

The annual generation rate $r(t)$ is:

$$r(t) = \begin{cases} B_y \cdot R_k & (t_m \leq t < t_{m+1} \quad (m = 0 \text{ to } K)) \\ 0 & (t \geq t_{trans}) \end{cases} \tag{9}$$

where m is the smallest integer such that $t \geq t_m$, and t_{trans} is computed to reach $S_{max} = 168000000$.

The general total supply of the customized halving model $S_{CH}(t)$ is:

$$S_{CH}(t) = \begin{cases} 0 & (t = 0) \\ \displaystyle\sum_{j=0}^{m-1} B_j \cdot R_j \;+\; B_y \cdot R_m \left(t - \sum_{j=0}^{m-1} T_j\right) & (0 < t < t_{fix}) \\ S_{fix} + r_f(t - t_{fix}) & (t_{fix} \leq t < t_{trans}) \\ S_{max} & (t \geq t_{trans}) \end{cases} \tag{10}$$

For the real circulating supply of the customized halving model $C_{CH}(t)$, incorporating continuous loss:

$$C_{CH}(t) = \begin{cases} 0 & (t = 0) \\ \displaystyle\sum_{j=0}^{m-1} H_j \cdot R_j \cdot e^{-\gamma\left(t - \left(\sum_{l=0}^{j-1} T_l + \frac{T_j}{2}\right)\right)} \;+\; \frac{B_y R_m}{\gamma}\left(1 - e^{-\gamma(t - \sum_{j=0}^{m-1} T_j)}\right) & (0 < t < t_{fix}) \\ C_{fix} \cdot e^{-\gamma(t - t_{fix})} \;+\; C^{\mathrm{ss}}\left(1 - e^{-\gamma(t - t_{fix})}\right) & (t_{fix} \leq t < t_{trans}) \\ C_{peak} \cdot e^{-\gamma(t - t_{trans})} & (t \geq t_{trans}) \end{cases} \tag{11}$$

where $C^{\mathrm{ss}} = r_f/\gamma$, and parameters like $\gamma = -\ln D$ remain as defined.

This form allows for arbitrary extensions, such as multiple fixed phases by appending to B_k and R_k (e.g., add repeated 1 RIN/block phases with $B_k = 2100000$ for 4 years each).

The customized periods are defined as follows (common to Scenarios I and II, index $k = 0$ to 6):

Block counts B_k: 210000, 210000, 210000, 210000, 1260000, 2100000, 2100000

Rewards R_k: 50, 25, 12.5, 6.25, 4, 2, 1

Period durations $T_k = B_k/B_y$

Let $t_0 = 0$, $t_{k+1} = t_k + T_k$ for $k = 0$ to 6, with $t_7 = t_{fix} \approx 11.9863$.

3.2 Scenario I: Constants and Definitions

In Scenario I, we assume a lower annual loss rate (1.3%), leading to a slower decay in circulating supply and a longer time to reach maximum supply.

$$
\begin{aligned}
B_y &= 525600 \quad \text{(Number of blocks per year)} \\
D &= 0.987 \quad \text{(Annual retention rate, 1.3\% loss)} \\
\gamma &= -\ln D \approx 0.01308524 \quad \text{(Continuous loss rate)} \\
R_{w,fix} &= 0.5 \quad \text{(Fixed block reward (RIN/block))} \\
r_f &= B_y \times R_{w,fix} = 262800 \quad \text{(Annual fixed supply increase)} \\
S_{\max} &= 168000000 \quad \text{(Maximum total supply)} \\
t_{fix} &\approx 11.9863 \quad \text{(Year when fixed reward starts)} \\
S_{\text{fix}} &= 31027500 \quad \text{(Cumulative supply at } t = t_{fix}\text{)} \\
C_{\text{fix}} &\approx 27336690.17 \quad \text{(Real circulating supply at } t = t_{fix}\text{)} \\
t_{trans} &\approx 533.1906 \quad \text{(Year when mining ends)} \\
C_{\text{peak}} &\approx 20091615.63 \quad \text{(Peak real circulating supply at } t = t_{trans}\text{)} \\
C^{\text{ss}} &= \frac{r_f}{\gamma} \approx 20083698.05 \quad \text{(Steady-state circulating supply)}
\end{aligned}
$$

3.2.1 Total Supply and Real Circulating Supply in Scenario I

The total supply and real circulating supply follow the general forms $S_{CH}(t)$ and $C_{CH}(t)$ defined in the framework section, using the parameters specific to Scenario I.

3.3 Scenario II: Constants and Definitions

In Scenario II, a higher annual loss rate (1.5%) and increased fixed reward accelerate the supply dynamics, resulting in a shorter mining period and higher steady-state circulating supply compared to Scenario I.

$$
\begin{aligned}
B_y &= 525600 \quad \text{(Number of blocks per year)} \\
D &= 0.985 \quad \text{(Annual retention rate, 1.5\% loss)} \\
\gamma &= -\ln D \approx 0.01511364 \quad \text{(Continuous loss rate)} \\
R_{w,fix} &= 0.6 \quad \text{(Fixed block reward (RIN/block))} \\
r_f &= B_y \times R_{w,fix} = 315360 \quad \text{(Annual fixed supply increase)} \\
S_{\max} &= 168000000 \quad \text{(Maximum total supply)} \\
t_{fix} &\approx 11.9863 \quad \text{(Year when fixed reward starts)} \\
S_{\text{fix}} &= 31027500 \quad \text{(Cumulative supply at } t = t_{fix}\text{)} \\
C_{\text{fix}} &\approx 26808700.14 \quad \text{(Real circulating supply at } t = t_{fix}\text{)} \\
t_{trans} &\approx 446.3232 \quad \text{(Year when mining ends)} \\
C_{\text{peak}} &\approx 20874300.07 \quad \text{(Peak real circulating supply at } t = t_{trans}\text{)} \\
C^{\text{ss}} &= \frac{r_f}{\gamma} \approx 20865922.82 \quad \text{(Steady-state circulating supply)}
\end{aligned}
$$

3.3.1 Total Supply and Real Circulating Supply in Scenario II

The total supply and real circulating supply follow the general forms $S_{CH}(t)$ and $C_{CH}(t)$ defined in the framework section, using the parameters specific to Scenario II.

3.4 Scenario III: Extended Fixed Phases with Scenario II Parameters

In Scenario III, we extend Scenario II by introducing an additional fixed reward phase at 1 RIN/block (k=7, with $B_7 = 2100000$ for approximately 4 years), before transitioning to the final fixed reward of 0.6 RIN/block (starting at k=8). This extension explores the impact of a temporary higher fixed reward on supply accumulation and loss dynamics, potentially stabilizing short-term circulation while maintaining long-term caps.

The customized periods for Scenario III are defined as follows (index $k = 0$ to 7):

Block counts B_k: 210000, 210000, 210000, 210000, 1260000, 2100000, 2100000, 2100000

Rewards R_k: 50, 25, 12.5, 6.25, 4, 2, 1, 1

Period durations $T_k = B_k/B_y$

Let $t_0 = 0$, $t_{k+1} = t_k + T_k$ for $k = 0$ to 7, with $t_8 = t_{fix} \approx 15.9817$.

$$\begin{aligned}
B_y &= 525600 \quad \text{(Number of blocks per year)} \\
D &= 0.985 \quad \text{(Annual retention rate, 1.5\% loss)} \\
\gamma &= -\ln D \approx 0.01511364 \quad \text{(Continuous loss rate)} \\
R_{w,fix} &= 0.6 \quad \text{(Fixed block reward (RIN/block))} \\
r_f &= B_y \times R_{w,fix} = 315360 \quad \text{(Annual fixed supply increase)} \\
S_{\max} &= 168000000 \quad \text{(Maximum total supply)} \\
t_{fix} &\approx 15.9817 \quad \text{(Year when final fixed reward starts)} \\
S_{\text{fix}} &= 33127500 \quad \text{(Cumulative supply at } t = t_{fix}\text{)} \\
C_{\text{fix}} &\approx 27275293.77 \quad \text{(Real circulating supply at } t = t_{fix}\text{)} \\
t_{trans} &\approx 443.6597 \quad \text{(Year when mining ends)} \\
C_{\text{peak}} &\approx 20875914.44 \quad \text{(Peak real circulating supply at } t = t_{trans}\text{)} \\
C^{\text{ss}} &= \frac{r_f}{\gamma} \approx 20865922.82 \quad \text{(Steady-state circulating supply)}
\end{aligned}$$

3.4.1 Total Supply and Real Circulating Supply in Scenario III

The total supply and real circulating supply follow the general forms $S_{CH}(t)$ and $C_{CH}(t)$ defined in the framework section, using the parameters and extended periods specific to Scenario III.

3.5 Comparison of Scenarios

To illustrate the impact of parameter variations and structural extensions, Table 1 compares key metrics across Scenarios I, II, and III. The extension in Scenario III increases t_{fix} by approximately 4 years and S_{fix} by 2.1 million RIN compared to Scenario II, slightly shortening the subsequent mining period (t_{trans}) while elevating initial circulating supply due to the additional phase.

Metric	Scenario I	Scenario II	Scenario III
γ	0.01308524	0.01511364	0.01511364
r_f	262800	315360	315360
t_{fix}	11.9863	11.9863	15.9817
S_{fix}	31027500	31027500	33127500
C_{fix}	27336690.17	26808700.14	27275293.77
t_{trans}	533.1906	446.3232	443.6597
C^{peak}	20091615.63	20874300.07	20875914.44
C^{ss}	20083698.05	20865922.82	20865922.82

Table 1: Comparison of key parameters and derived metrics across scenarios.

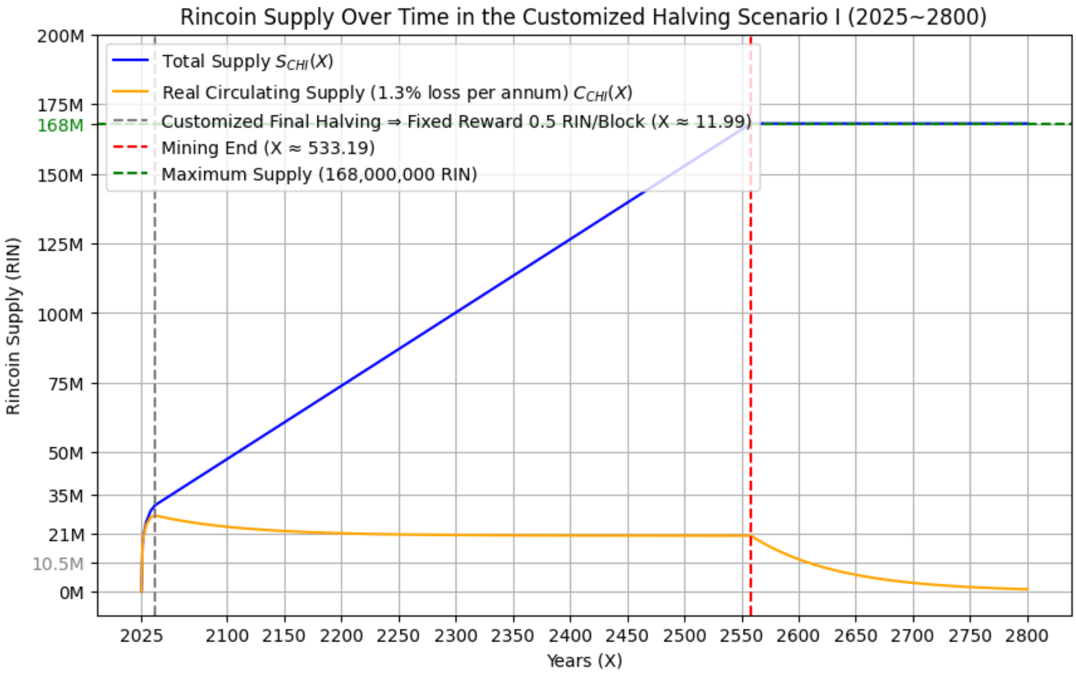

Figure 2: Rincoin Supply Over Time in the Customized Halving Scenario I (2025–2800).

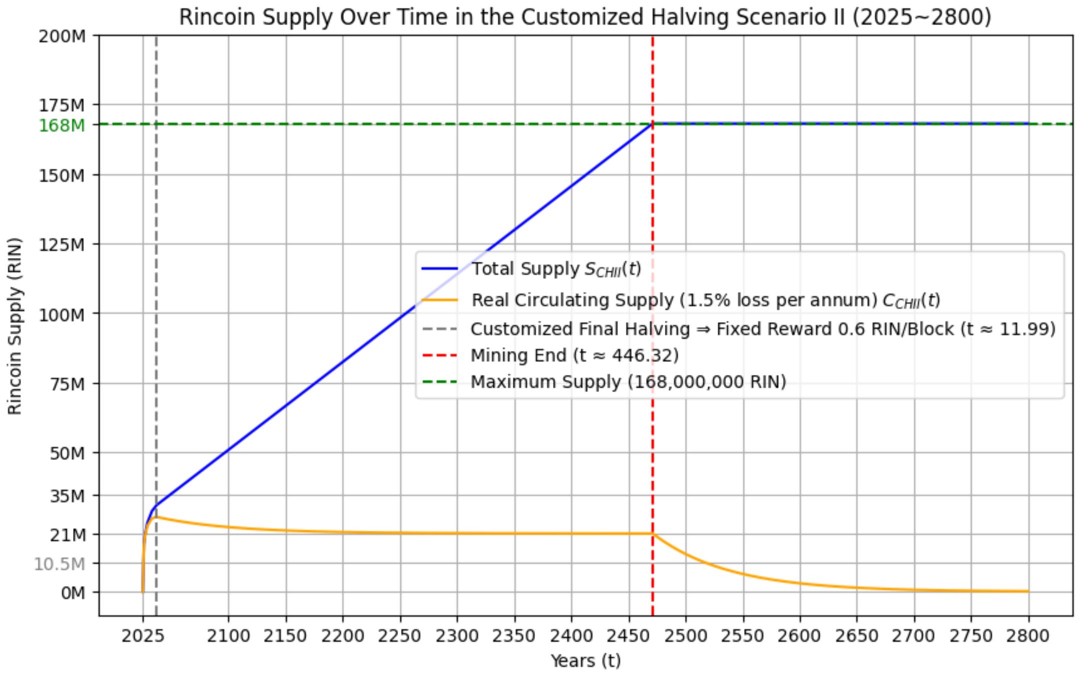

Figure 3: Rincoin Supply Over Time in the Customized Halving Scenario II (2025–2800).

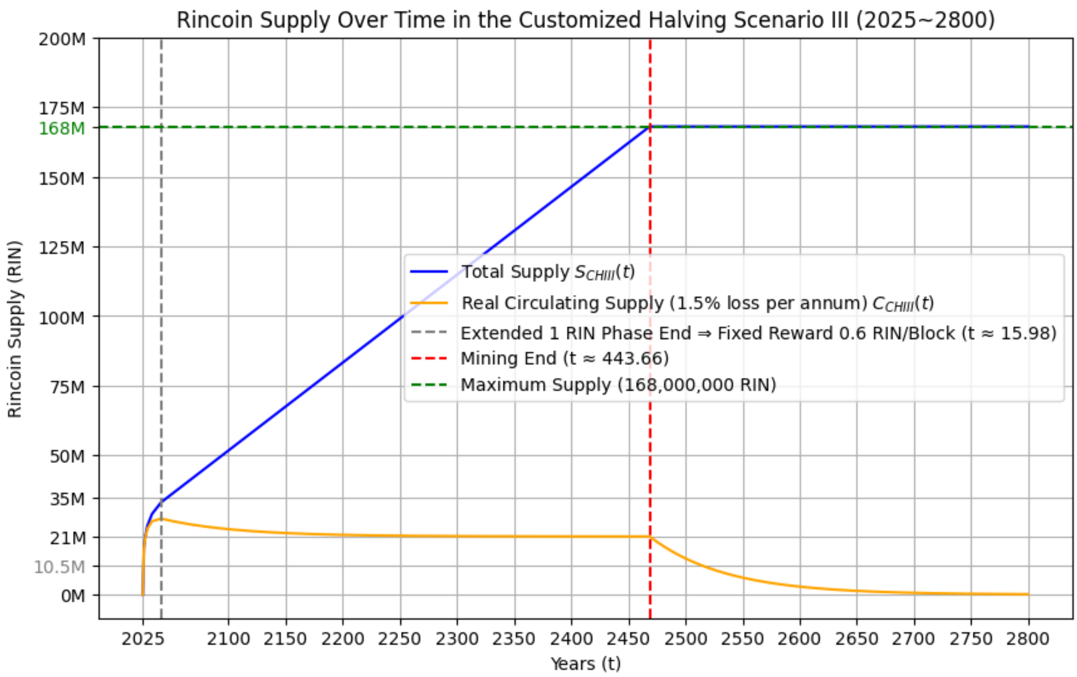

Figure 4: Rincoin Supply Over Time in the Customized Halving Scenario III (2025–2800). The total supply $S_{CHIII}(t)$ (blue) increases until reaching the maximum supply of 168,000,000 RIN at $t \approx 443.66$. The real circulating supply $C_{CHIII}(t)$ (orange) accounts for a 1.5% annual loss, peaking at $t \approx 443.66$ and declining thereafter. Key events include the customized final halving at $t \approx 15.98$ leading to a fixed reward of 0.6 RIN/block and mining end. This mechanism ensures long-term stability and symbolism in Rincoin's emission schedule. In this scenario, Rincoin could also function as a virtual Bitcoin for approximately 443 years.

4 Conclusion

In summary, the proposed frameworks for Rincoin's emission schedules achieve a balance between symbolic scarcity and practical stability. The fixed-reward model maintains circulating supply near Bitcoin's maximum supply for centuries, while the customized halving extends mining viability and preserve the network security. Future work could include the expansion of the customized halving mechanisms, stochastic simulations of loss rates or empirical validation post-launch. These models provide a blueprint for sustainable cryptocurrency design. In the future, we plan to add detailed information for customized halving scenarios, expand each formula, simulations, and develop new concepts.

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