Modeling Rincoin Supply for the Symbolism and Stability (Preliminary Version 1.1.1)

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1 Definition of Constants

$$
\begin{aligned}
A &= 525600 \quad \text{(Number of blocks per annual, block time = 60 s)} \\
B &= 210000 \quad \text{(Number of blocks per halving)} \\
R_0 &= 50 \quad \text{(Initial block reward (RIN))} \\
T &= 0.399543 \quad \text{(Halving interval (years))} \\
X_0 &= 2.796801 \quad \text{(Year when reward is fixed at 0.4 RIN, 1470000 Block)} \\
X_{\text{max}} &= 702.778072 \quad \text{(Year when total supply reaches the upper limit)} \\
r_{\text{fixed}} &= 0.4 \quad \text{(Fixed block reward (RIN/Block))} \\
r_f &= A \times r_{\text{fixed}} \quad \text{(Annual fixed supply increase)} \\
S_{\text{fix}} &= 20835937.5 \quad \text{(Cumulative supply at } X = X_0\text{)} \\
C_{\text{fix}} &= 20376559.61 \quad \text{(Real circulating supply at } X = X_0\text{)} \\
C_{\text{peak}} &= 20918226.57 \quad \text{(Real circulating supply at } X = X_{\text{max}}\text{)} \\
D &= 0.99 \quad \text{(Annual loss rate)}
\end{aligned}
$$

2 Total Supply of Rincoin $S_R(X)$

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

$$
\frac{dS}{dX} = r(X), \quad S(0) = 0,
$$

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

$$
r(X) = \begin{cases} AR_0 \left(\frac{1}{2}\right)^k & \text{if } 0 \le X < X_0 \\ r_f & \text{if } X_0 \le X < X_{\text{max}} \\ 0 & \text{if } X \ge X_{\text{max}} \end{cases}
$$

And $k = \lfloor \frac{X}{T} \rfloor$.

Basically speaking, the total supply function of Rincoin $S_R(X)$ when the block reward is fixed at 0.4 RIN at $X = X_0$ is expressed by the following algebraic equation.

$$
S_R(X) = \begin{cases} 0 & \text{if } X = 0 \\ 2BR_0\left(1 - 0.5^k\right) + AR_0(X - Tk) \cdot 0.5^k & \text{if } 0 < X < X_0 \\ S_{\text{fix}} + \frac{2A}{5}(X - X_0) & \text{if } X_0 \le X < X_{\text{max}} \\ 168000000 & \text{if } X \ge X_{\text{max}} \end{cases}
$$

3 Real Circulating Supply of Rincoin $C_R(X)$

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

$$\frac{dC}{dX} = r(X) - \gamma C, \quad C(0) = 0,$$

and $\gamma = -\ln D \approx 0.01005$, but strictly speaking, it is expressed by the following algebraic equation：

$$C_R(X) = \begin{cases} 0 & \text{if } X = 0 \\ BR_0 D^{X+T/2}\frac{1-q^k}{1-q} + AR_0 0.5^k (X - Tk) D^{X-Tk-(X-Tk)/2} & \text{if } 0 < X < X_0 \\ C_{\text{fix}} D^{X-X_0} + \frac{2A/5}{1-D}\left(1 - D^{X-X_0}\right) & \text{if } X_0 \le X < X_{\max} \\ C_{\text{peak}} D^{X-X_{\max}} & \text{if } X \ge X_{\max} \end{cases}$$

$k = \lfloor \frac{X}{T} \rfloor$, $q = 0.5D^{-T}$, $C_R(X)$ also fixes the block reward to 0.4 RIN at $X = X_0$.

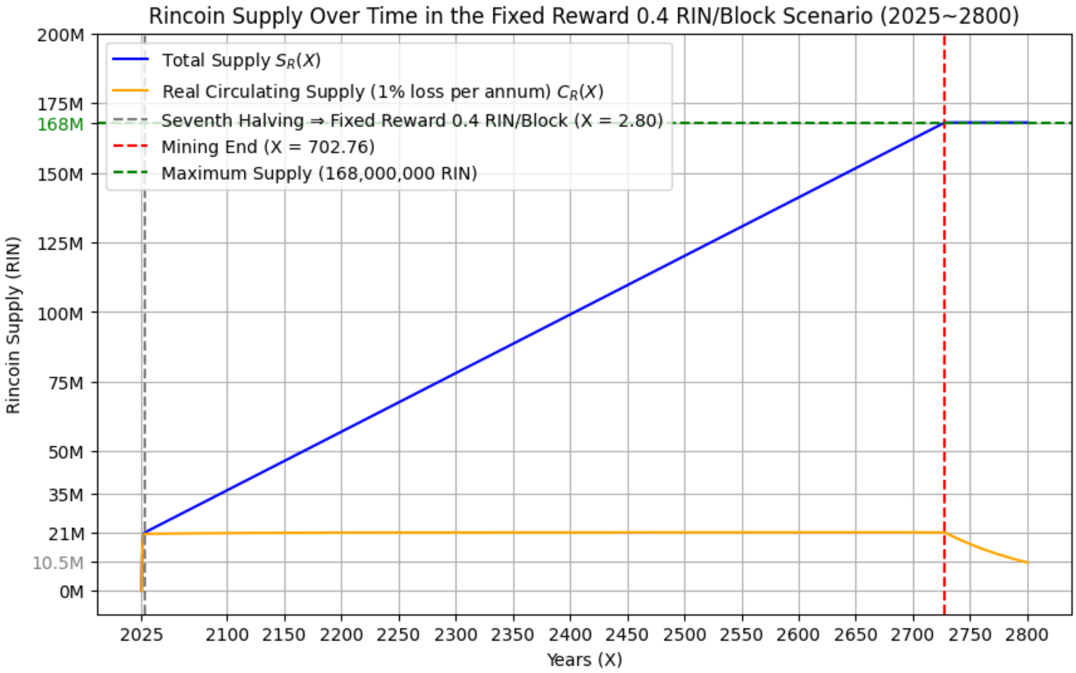

Figure 1: Rincoin Supply Over Time in the Fixed Reward 0.4 RIN/Block Scenario (2025–2800). The total supply $S_R(X)$ (blue) increases until reaching the maximum supply of 168,000,000 RIN at $X = 702.76$. The real circulating supply $C_R(X)$ (orange) accounts for a 1% annual loss, peaking at $X = 702.76$ and declining thereafter. Key events include the seventh halving at $X = 2.80$ and mining end. Rincoin's effective circulating supply remains within the bounds of Bitcoin's maximum supply, allowing Rincoin to function as a virtual Bitcoin.

4 General Forms of the Total Supply $S(X)$ and Real Circulating Supply $C(X)$

To generalise the expressions, introduce the following additional constants:

$$\begin{aligned} r_{\text{fixed}} &= 0.4 \quad \text{(Fixed block reward (RIN/Block))} \\ r_f &= A \times r_{\text{fixed}} \quad \text{(Annual fixed supply increase)} \\ \gamma &= -\ln D \quad \text{(Loss rate)} \\ C^{\text{ss}} &= \frac{r_f}{\gamma} \quad \text{(The steady-state circulating supply during the fixed reward period)} \end{aligned}$$

The general form for the total supply $S(X)$ is:

$$S(X) = \begin{cases} 0 & \text{if } X = 0 \\ \sum_{j=0}^{k-1} BR_0 \left(\frac{1}{2}\right)^j + AR_0(X - Tk) \left(\frac{1}{2}\right)^k & \text{if } 0 < X < X_0 \\ S_{\text{fix}} + r_f(X - X_0) & \text{if } X_0 \leq X < X_{\max} \\ S_{\max} & \text{if } X \geq X_{\max} \end{cases}$$

$S_{\max} = 168000000$, $k = \lfloor \frac{X}{T} \rfloor$, and the sum in the halving period is equivalent to $2BR_0 \left(1 - 0.5^k\right)$.

For the real circulating supply $C(X)$, the strict general form using continuous decay is:

$$C(X) = \begin{cases} 0 & \text{if } X = 0 \\ \sum_{j=0}^{k-1} BR_0 \left(\frac{1}{2}\right)^j e^{-\gamma(X - T(j+0.5))} + \frac{r_k}{\gamma} \left(1 - e^{-\gamma(X-Tk)}\right) & \text{if } 0 < X < X_0 \\ C_{\text{fix}} e^{-\gamma(X-X_0)} + C^{\text{ss}} \left(1 - e^{-\gamma(X-X_0)}\right) & \text{if } X_0 \leq X < X_{\max} \\ C_{\text{peak}} e^{-\gamma(X - X_{\max})} & \text{if } X \geq X_{\max} \end{cases}$$

$r_k = AR_0 \left(\frac{1}{2}\right)^k$ (annual supply increase in the current halving period) and the discrete approximation using D (as in the previous section) is a midpoint approximation for the exponential decay, with $D^y \approx e^{-\gamma y}$. The form using D is simpler for discrete annual calculations, while the exponential form is more precise for continuous models.

5 Total Supply Inflation Rate of Rincoin $I_{SR}(X)$

The inflation rate of the total supply $I_{SR}(X)$ is derived from the differential equation for $S_R(X)$:

$$\frac{dS_R}{dX} = r(X), \quad S_R(0) = 0,$$

as

$$I_{SR}(X) = \frac{1}{S_R(X)} \frac{dS_R}{dX} = \frac{r(X)}{S_R(X)}.$$

Strictly speaking, the total supply inflation rate $I_{SR}(X)$ is expressed by the following algebraic equation using the piecewise definitions of $r(X)$ and $S_R(X)$:

$$I_{SR}(X) = \frac{r(X)}{S_R(X)},$$

where $S_R(X)$ is:

$$S_R(X) = \begin{cases} 0 & \text{if } X = 0 \\ \sum_{j=0}^{k-1} BR_0 \left(\frac{1}{2}\right)^j + AR_0(X - Tk) \left(\frac{1}{2}\right)^k & \text{if } 0 < X < X_0 \\ S_{\text{fix}} + r_f(X - X_0) & \text{if } X_0 \leq X < X_{\max} \\ 168000000 & \text{if } X \geq X_{\max} \end{cases}$$

And the sum in the halving period is equivalent to $2BR_0 \left(1 - 0.5^k\right)$, with $k = \lfloor \frac{X}{T} \rfloor$.

6 Real Circulating Supply Inflation Rate of Rincoin $I_{CR}(X)$

The inflation rate of the real circulating supply $I_{CR}(X)$ is derived from the differential equation for $C_R(X)$:

$$\frac{dC_R}{dX} = r(X) - \gamma C_R, \quad C_R(0) = 0,$$

as

$$I_{CR}(X) = \frac{1}{C_R(X)} \frac{dC_R}{dX} = \frac{r(X)}{C_R(X)} - \gamma.$$

Strictly speaking, it is expressed by the following algebraic equation:

$$I_{CR}(X) = \frac{r(X)}{C_R(X)} - \gamma,$$

where $C_R(X)$ is:

$$C_R(X) = \begin{cases} 0 & \text{if } X = 0 \\ \sum_{j=0}^{k-1} BR_0 \left(\frac{1}{2}\right)^j e^{-\gamma(X - T(j+0.5))} + \frac{r_k}{\gamma}\left(1 - e^{-\gamma(X - Tk)}\right) & \text{if } 0 < X < X_0 \\ C_{\text{fix}} e^{-\gamma(X - X_0)} + C^{\text{ss}}\left(1 - e^{-\gamma(X - X_0)}\right) & \text{if } X_0 \le X < X_{\max} \\ C_{\text{peak}} e^{-\gamma(X - X_{\max})} & \text{if } X \ge X_{\max} \end{cases}$$

With $r_k = AR_0 \left(\frac{1}{2}\right)^k$ (annual increase in supply in the current halving period) and $k = \lfloor \frac{X}{T} \rfloor$. Note that the form using exponential decay is precise for continuous models, while discrete approximations using D may be used for annual calculations.

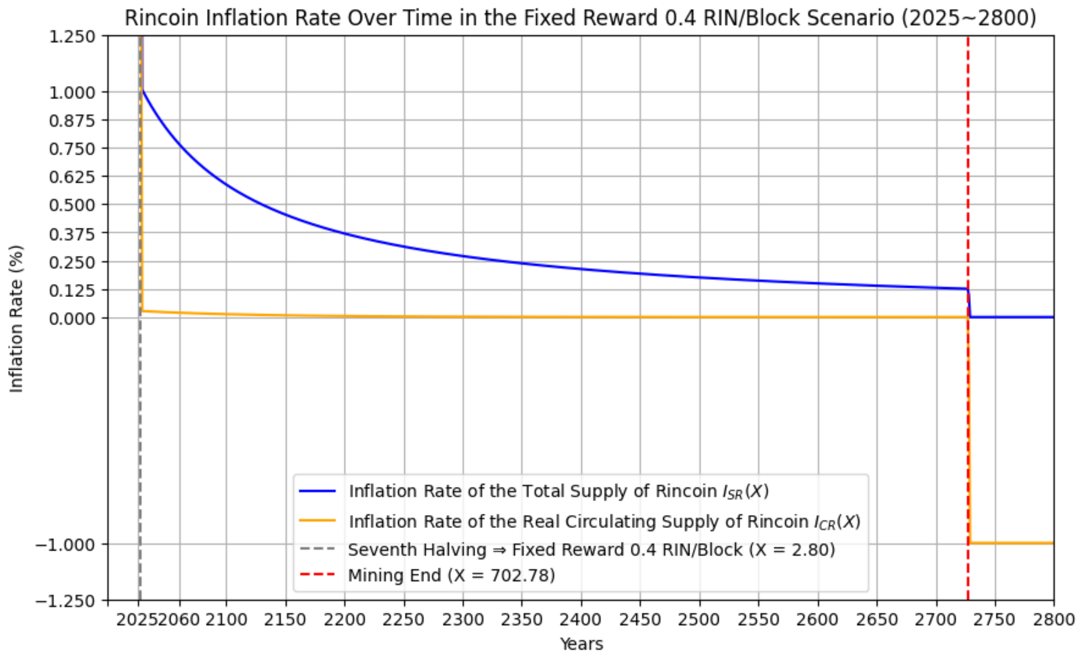

Figure 2: Rincoin Inflation Rate Over Time in the Fixed Reward 0.4 RIN/Block Scenario (2025–2800). The inflation rate of the total supply $I_{SR}(X)$ (blue) decreases over time until mining ends at $X = 702.78$, after which it is zero. The inflation rate of the real circulating supply $I_{CR}(X)$ (orange) accounts for the 1% annual loss, approaching $-\gamma \approx -1\%$ after mining ends. Key events include the seventh halving at $X = 2.80$ and mining end.

7 General Forms of the Total Supply Inflation Rate $I_S(X)$

The inflation rate for the total supply, $I_S(X)$, represents the relative rate at which new tokens are added to the total supply. It is defined as:

$$I_S(X) = \frac{r(X)}{S(X)},$$

where $r(X)$ is the annual generation rate, given by:

$$r(X) = \begin{cases} AR_0 \left(\frac{1}{2}\right)^k & \text{if } 0 \le X < X_0 \\ r_f & \text{if } X_0 \le X < X_{\max} \\ 0 & \text{if } X \ge X_{\max} \end{cases}$$

$k = \lfloor \frac{X}{T} \rfloor$, $r_f = A \times 0.4$, and $S(X)$ is the total supply, expressed as:

$$S(X) = \begin{cases} 0 & \text{if } X = 0 \\ \sum_{j=0}^{k-1} BR_0 \left(\frac{1}{2}\right)^j + AR_0(X - Tk) \left(\frac{1}{2}\right)^k & \text{if } 0 < X < X_0 \\ S_{\text{fix}} + r_f(X - X_0) & \text{if } X_0 \le X < X_{\max} \\ S_{\max} & \text{if } X \ge X_{\max} \end{cases}$$

With $S_{\max} = 168000000$, and the sum in the halving period is equivalent to $2BR_0 \left(1 - 0.5^k\right)$. This summation accounts for the cumulative rewards from previous halving periods, plus the prorated reward in the current period.

To derive this general form for $I_S(X)$, it comes directly from the differential equation governing the total supply: $\frac{dS}{dX} = r(X)$ with initial condition $S(0) = 0$. The inflation rate is then the relative growth rate: $I_S(X) = \frac{1}{S(X)} \frac{dS}{dX} = \frac{r(X)}{S(X)}$. The piecewise definitions of $r(X)$ and $S(X)$ are substituted into this expression. Note that at $X = 0$, $I_S(X)$ is undefined due to division by zero (since $S(0) = 0$), but as X approaches 0 from the right, $I_S(X)$ approaches infinity, reflecting the initial high issuance rate relative to the negligible supply.

8 Real Circulating Supply Inflation Rate $I_C(X)$

The inflation rate for the real circulating supply, $I_C(X)$, accounts for both the generation of new coins and the loss over time. It is defined as:

$$I_C(X) = \frac{r(X)}{C(X)} - \gamma,$$

where $r(X)$ is as defined above, $\gamma = -\ln D \approx 0.01005$ (the continuous loss rate corresponding to the annual discrete loss rate $D = 0.99$), and $C(X)$ is the real circulating supply, given by:

$$C(X) = \begin{cases} 0 & \text{if } X = 0 \\ \sum_{j=0}^{k-1} BR_0 \left(\frac{1}{2}\right)^j e^{-\gamma(X - T(j+0.5))} + \frac{r_k}{\gamma} \left(1 - e^{-\gamma(X - Tk)}\right) & \text{if } 0 < X < X_0 \\ C_{\text{fix}} e^{-\gamma(X - X_0)} + C^{\text{ss}} \left(1 - e^{-\gamma(X - X_0)}\right) & \text{if } X_0 \le X < X_{\max} \\ C_{\text{peak}} e^{-\gamma(X - X_{\max})} & \text{if } X \ge X_{\max} \end{cases}$$

With $r_k = AR_0 \left(\frac{1}{2}\right)^k$ (the annual generation rate in the current halving period) and $C^{\text{ss}} = \frac{r_f}{\gamma}$ (the steady-state circulating supply during the fixed reward phase, where the generation balances loss).

This form for $I_C(X)$ is derived from the differential equation for the circulating supply: $\frac{dC}{dX} = r(X) - \gamma C$ with $C(0) = 0$, which incorporates continuous loss at rate γ. The inflation rate is the relative growth rate: $I_C(X) = \frac{1}{C(X)} \frac{dC}{dX} = \frac{r(X)}{C(X)} - \gamma$. The piecewise expressions for $r(X)$ and $C(X)$ are plugged in directly. Similarly to $I_S(X)$, at $X = 0$, $I_C(X)$ is undefined and approaches infinity as X approaches 0 from the right.