Bitcoin-Seconds: A Time-Valued Measure of Real Economic Utility

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1 Bitcoin-Seconds

1.1 Motivation

Traditional macroeconomic measures of "real" value rely on inflation-adjusted fiat units, whose calibration and publication are often politically influenced. In a Bitcoin-denominated economy, the unit of account is immutable, timestamped, and globally verifiable. We propose **Bitcoin-Seconds (BS)**: a continuous, time-based measure of individual or organizational economic efficacy that integrates productive Bitcoin activity, inflation-adjusted consumption, and wealth accumulation over a lifetime horizon.

Bitcoin-Seconds quantifies *economic vitality in time*, echoing the metaphor of the film *In Time* (2011), where lifespan is measured in seconds of purchasing power. Here, the metric expresses how effectively one converts Bitcoin-denominated wealth into sustainable, inflation-resilient utility.

1.2 Definitions and Notation

Let $t \in [0, T]$ denote continuous time, measured in seconds. We define the following measurable functions:

- $A(t)$ — Expected UTXO (coin) age [seconds] (value-weighted mean age of coins held).
- $W(t)$ — Bitcoin stock (wealth) [satoshis].
- $Y(t)$ — Income rate [satoshis per second].
- $R(t)$ — Retirement income rate [satoshis per second].
- $c(t)$ — Consumption (spend) rate [satoshis per second].
- ι_t — Real inflation rate [per second], derived from the Truflation index.
- ρ — Discount rate [per second], modeling time preference.

All functions are assumed bounded, piecewise continuous, and integrable on $[0, T]$.

1.3 Instantaneous Utility Function

At any instant t, Bitcoin economic utility is given by

$$u(t) = \alpha A(t)Y(t) + \beta R(t) - \gamma \iota_t c(t), \tag{1}$$

where $\alpha, \beta, \gamma > 0$ are calibration constants controlling the respective contribution of productive coin-age, retirement inflows, and inflation drag. Each term in (1) has units of satoshis per second (sats/s).

1.4 Discounted Utility and Spending Integrals

Define the discounted total utility:

$$U_\rho(T) = \int_0^T e^{-\rho t}\big[\alpha A(t)Y(t) + \beta R(t) - \gamma \iota_t c(t)\big]\, dt, \tag{2}$$

and the discounted total consumption:

$$S_\rho(T) = \int_0^T e^{-\rho t} c(t)\, dt. \tag{3}$$

1.5 The Bitcoin-Seconds Index

The Bitcoin-Seconds Index is defined as the ratio of discounted productive utility to discounted expenditure:

$$BS_\rho(T) = \frac{\int_0^T e^{-\rho t}\big[\alpha A(t)Y(t) + \beta R(t) - \gamma \iota_t c(t)\big]\, dt}{\int_0^T e^{-\rho t}\, c(t)\, dt}. \tag{4}$$

This ratio is dimensionless, scale-invariant, and bounded for $\rho > 0$ under finite utility and consumption flows. The limit $BS_\rho(\infty)$ exists whenever both integrals converge.

1.6 Properties

1. **Dimensional Consistency:** All terms have identical units, ensuring BS_ρ is dimensionless.
2. **Scale Invariance:** $BS_\rho(\lambda W, \lambda Y, \lambda R, \lambda c) = BS_\rho(W, Y, R, c)$ for any $\lambda > 0$.
3. **Boundedness:** If A, Y, R, c, ι_t are bounded, and $\rho > 0$, then $BS_\rho(T)$ is bounded for all finite T.
4. **Monotonicity:** $\frac{\partial BS}{\partial A}, \frac{\partial BS}{\partial Y}, \frac{\partial BS}{\partial R} > 0$; $\frac{\partial BS}{\partial \iota}, \frac{\partial BS}{\partial c} < 0$.

1.7 Discrete Implementation

For discrete time steps $k = 1, \ldots, T$, with step size Δt and $\delta = e^{-\rho \Delta t}$:

$$BS_\rho(T) = \frac{\sum_{k=1}^{T} \delta^k [\alpha A_k Y_k + \beta R_k - \gamma \iota_k c_k]}{\sum_{k=1}^{T} \delta^k c_k}. \tag{5}$$

This form is suitable for monthly or daily updates from wallet logs and inflation feeds.

1.8 Interpretation

$BS_\rho > 0$ indicates that productive accumulation exceeds inflation-adjusted consumption; $BS_\rho = 0$ represents equilibrium; and $BS_\rho < 0$ indicates a net loss of purchasing power in Bitcoin terms. For communication, BS_ρ can be reported as a rate—e.g., "the entity is generating 0.002 Bitcoin-Seconds per second."

1.9 Data Sources and Calibration

The inflation term ι_t is computed from a transparent, independent source such as the Truflation index:

$$\iota_t = \frac{1}{\Delta t} \ln\left(\frac{\text{Truflation}(t)}{\text{Truflation}(t - \Delta t)} \right). \tag{6}$$

The parameters α, β, γ may be calibrated so that $BS_\rho \in [-1, 1]$ under a chosen baseline.

1.10 Conclusion

Bitcoin-Seconds provides a unified temporal framework to measure economic vitality in a Bitcoin-denominated economy. It formalizes the interplay between coin age, productivity, inflation, and consumption into a bounded, invariant, and human-readable metric that treats *time itself* as the fundamental unit of economic life.