Bitcoin-Seconds (BXS): Flow, Stock, and Time-Weighted Stock

Version 0.6.1 (for Peer Review)

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Abstract

We formalize **Bitcoin-Seconds (BXS)** as a three-level, Bitcoin-native temporal framework: (1) an instantaneous productive flow in sats per second, (2) its cumulative integral in sats, and (3) a time-weighted integral in sats $\cdot$ s. To address concerns of arbitrariness, we ground the flow in a standard economic aggregator: income scaled by a *dimensionless deployment efficiency* built from measurable Bitcoin-state variables (e.g., coin age, protocol expansion, and surplus-to-spend posture) with calibratable elasticities. We keep a *core baseline* BXS defined as the time integral of wealth for comparability, and include the earlier heuristic in an appendix for continuity. We propose falsifiable hypotheses and a practical calibration plan (node-local, Start9 + mempool.space).

1 Scope and Philosophy

BXS tracks *flow* (sats/s), *stock* (sats), and *time-weighted stock* (sats s) in Bitcoin units without relying on fiat conversions. The goal is not to mimic physics but to provide a Bitcoin-native, interpretable, and testable measure of *economic activity through time*.

2 Data Inputs and Notation

Time $t \in [0, T]$ is in seconds. Let:

- $W(t)$: wealth/holdings [sats].
- $i(t)$: income inflow [sats s^{-1}].
- $\mu(t)$: spending rate [sats s^{-1}].
- $A(t)$: value-weighted coin age [s].

- $I(t)$: instantaneous protocol expansion (monetary dilution) $[\mathrm{s}^{-1}], definedmechanicallybyI(t) = \frac{\sigma(h(t))}{S(t)}\,\lambda(t)$, where $\sigma(h)$ is subsidy (BTC per block), $S(t)$ is circulating supply (BTC), and $\lambda(t)$ is block arrival rate (blocks per second).

$s(t)$: shorthand for current balance [sats] when needed.

$CP(t)$: cumulative CPI-weighted cost [sats] (optional external index).

r: retirement horizon [s], used in surplus posture.

ρ: time preference/discount rate $[\mathrm{s}^{-1}](set\rho = 0$ if undesired).

Local provenance. We compute $I(t)$ from a *locally hosted* mempool.space instance on Start9 (subsidy, supply, cadence). Wallet state yields W, i, μ, A. This is sovereign and reproducible without third-party APIs.

3 BXS Ladder (Preserved)

3.1 Level 1: Instantaneous Productive Flow (sats/s)

We preserve the BTC/s $\rightarrow$ BTC $\rightarrow$ BTC·s ladder by defining flow as

$$\boxed{f(t) \;=\; i(t)\,\mathcal{E}(t) \quad \text{(units: sats s}^{-1}\text{).}}$$

Here $\mathcal{E}(t)$ is a *dimensionless deployment efficiency* that maps observable states into productivity.

A standard, interpretable choice is a Cobb–Douglas aggregator over Bitcoin-native drivers:

$$\boxed{\mathcal{E}(t) \;=\; \left(\frac{A(t)}{A_0}\right)^{\alpha}\left(\frac{I(t)}{I_0}\right)^{\beta}\left(\frac{s(t)+r\,i(t)-CP(t)}{t\,\mu(t)}\right)^{\gamma}}$$

where A_0 and I_0 are baselines (e.g., rolling medians) to normalize units. Elasticities α, β, γ are *calibrated* (see Section 6) and give economic meaning: coin-age sensitivity, protocol-dilution sensitivity, and surplus-to-spend sensitivity, respectively. *Your original v0.5 product* appears as the special case $\alpha = \beta = \gamma = 1$.

Companion ratio (interpretability). Define the *Time Monetization Efficiency*:

$$\mathrm{TME}(t) \;=\; \frac{f(t)}{W(t)} \;\in\; \mathrm{s}^{-1},$$

interpreted as the fraction of wealth actively converting per second. This normalizes activity by size and enables cross-entity comparison.

3.2 Level 2: Cumulative Bitcoin (sats)

$$\boxed{S(T) \;=\; \int_0^T f(t)\,dt \quad \text{(units: sats).}}$$

3.3 Level 3: Bitcoin-Seconds (sats s)

$$\boxed{\mathrm{BXS}(T) \;=\; \int_0^T S(t)\,dt \;=\; \int_0^T\!\!\int_0^t f(\tau)\,d\tau\,dt \quad \text{(units: sats s).}}$$

BXS is the *time-weighted accumulation* of productive flow.

4 Baseline for Comparison: Core BXS (Integral of Wealth)

For benchmarking and ablation we track a baseline:

$$\boxed{\mathrm{BXS}_{\mathrm{core}}(T) \;=\; \int_0^T e^{-\rho t}\,W(t)\,dt \quad \text{(sats s).}}$$

This is simply the discounted area-under-wealth. It makes BXS interpretable even without specifying $\mathcal{E}(t)$, and it lets us test whether the deployment-adjusted ladder adds predictive information.

5 Interpretation

- $f(t)$ (sats/s): productive conversion rate of income into Bitcoin-native output, modulated by measurable states via $\mathcal{E}(t)$.
- $S(T)$ (sats): cumulative production/throughput over the horizon.

- $\mathrm{BXS}(T)$ (sats s): duration-weighted cumulative production; *how much* output persisted *for how long.*
- $\mathrm{BXS}_{\mathrm{core}}$ (sats s): area under wealth; a neutral baseline capturing size and duration of custody.
- $\mathrm{TME}(t)$ (s^{-1}): share of wealth actively converting each second; useful as an activity/health signal.

6 Calibration and Testing

Goal: demonstrate that the deployment-adjusted ladder (f, S, BXS) adds information versus balance (W), hodl-age, ROI, and the core baseline ($\int W\,dt$).

Elasticities. Estimate (α, β, γ) by minimizing out-of-sample forecast loss on target outcomes:

- Early-warning of stress (forced selling, fee sensitivity spikes, exchange reliance).
- Execution impact for miners/treasuries (slippage, realized losses).
- Persistence of activity ($f(t+\Delta)$ given W and age).

Methods: log-log OLS, CES variants, regularization; evaluate with rolling windows and Diebold-Mariano tests versus baselines.

Hypotheses (falsifiable).

- H1: Higher $\mathrm{TME}(t)$ predicts higher $f(t+\Delta)$ controlling for W and A.
- H2: Given equal W, higher $\mathrm{BXS}(T)$ and non-collapsing TME reduce near-term stress odds.
- H3: Including $A(t)$ and $I(t)$ in $\mathcal{E}(t)$ improves execution-risk forecasts beyond W or hodl-age alone.

7 Illustrative Numerics (Undiscounted)

Take $\rho = 0$ for clarity.

Satoshi-like Holder (large, long, mostly idle)

Let $W \approx 9.68452 \times 10^{13}$ sats and a horizon $T \approx 4.0 \times 10^{8}$ s. Then

$$\mathrm{BXS}_{\mathrm{core}}(T) \approx W\,T \approx 3.87 \times 10^{22} \text{ sats s.}$$

This reflects very high duration-weighted custody regardless of daily flow.

Modest Holder (about 1.2 BTC)

$W \approx 1.2 \times 10^{8}$ sats for one year $T \approx 3.15 \times 10^{7}$ s yields $\mathrm{BXS}_{\mathrm{core}} \approx 3.78 \times 10^{15}$ sats s. If i, μ, A, I are known, plug into $\mathcal{E}(t)$ to get f, S, BXS.

Micro Holder (0.001337 BTC)

$W \approx 1.337 \times 10^{5}$ sats over $T \approx 2.0 \times 10^{6}$ s gives $\mathrm{BXS}_{\mathrm{core}} \approx 2.67 \times 10^{11}$ sats s.

8 Historical Context for $I(t)$

Representative snapshots using $I(t) = \sigma/S \cdot \lambda$ (assume 600 s cadence for clarity):

Era	σ (BTC/block)	S (BTC)	$I(t)$ [s^{-1}]
Genesis (2009, $h \approx 1{,}000$)	50	50,000	1.67×10^{-6}
Satoshi window (2010, $h \approx 54{,}000$)	50	2.7×10^{6}	3.07×10^{-8}
1st Halving (2012, $h \approx 210{,}000$)	50	1.05×10^{7}	7.94×10^{-9}
2025 snapshot ($h \approx 922{,}000$)	3.125	1.994×10^{7}	2.61×10^{-10}

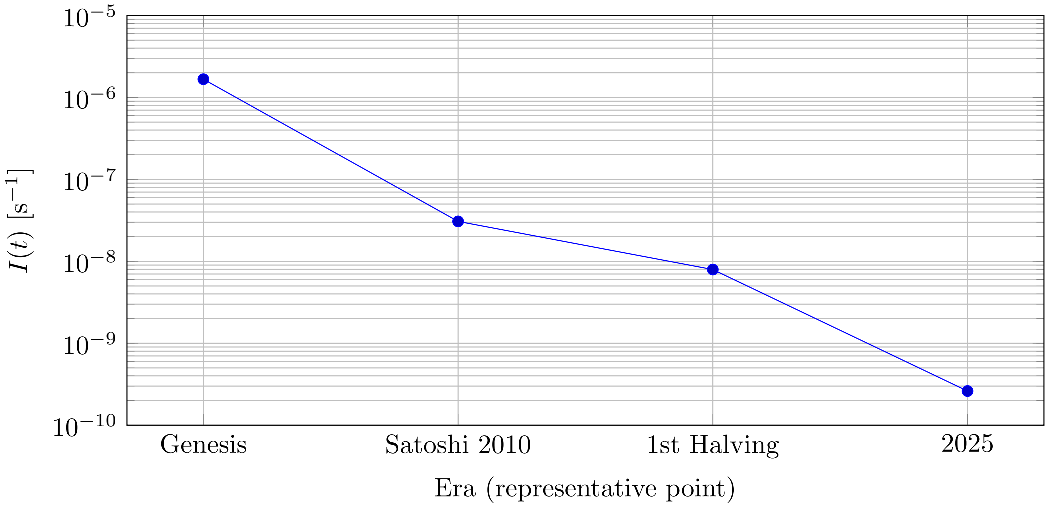

Figure 1: *
Epoch-level decline of the instantaneous protocol expansion rate $I(t)$.

9 Positioning Note (Convergent Thinking)

Related work explores time-centric monetization ideas. We reference such work only as an instance of independent convergence on the importance of time-weighted value. The present construction is Bitcoin-native and self-contained.

10 Conclusion

BXS preserves your intuitive ladder (BTC/s to BTC to BTC s) while adding a principled efficiency layer that is interpretable and testable. The baseline $\int W\,dt$ keeps things grounded; the deployment-adjusted ladder should prove its worth by outperforming baselines in prediction and decision support. Everything is implementable with a sovereign node stack.

Appendix A: Implementation Notes (Local Node)

All quantities are computed from a Start9-hosted mempool.space:

- $I(t)$ from subsidy, supply, and measured block cadence.
- $W(t), i(t), \mu(t), A(t)$ from wallet state and logs.
- Optional CPI feeds for $CP(t)$ if desired (or omit entirely to stay Bitcoin-native).

Appendix B: Core vs. Deployment-Adjusted BXS

- Core: $\mathrm{BXS}_{\mathrm{core}} = \int e^{-\rho t} W(t)\, dt$ (no flow modeling).
- Deployment-adjusted: compute $f = i\mathcal{E}$, then $S = \int f$, then $\mathrm{BXS} = \int S$.
- Evaluate incremental value by out-of-sample tests against W, hodl-age, ROI, and $\int W\, dt$.

Appendix C: Heuristic Flow (v0.5.x) for Reference Only

Earlier drafts used a direct multiplicative flow:

$$f_{\mathrm{heur}}(t) \;=\; i(t) \cdot A(t) \cdot I(t) \cdot \frac{\big(s(t) + r\, i(t)\big) - CP(t)}{t\, \mu(t)}.$$

It is *dimensionally consistent* but not micro-founded. In the present paper, it is treated as a candidate component inside the efficiency map $\mathcal{E}(\cdot)$. If data show it adds no value, it should be replaced or dropped.